

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																				
1.2	Run IIb Trigger Upgrade	11/1/01	3/16/05	\$1,429,918	\$1,308,600	\$98,203	\$2,836,721																																				
<div>Notes</div> <div>WBS Definition-</div> <div>The Level 1 trigger upgrade is designed to allow us to maintain the peak output rate of 5 kHz at the higher luminosities of Run 2b. This will be accomplished by upgrades to three systems - the Level 1 calorimeter trigger, a calorimeter cluster track match at Level 1, and the Level 1 central track trigger. Procurement of additional Level 2 beta processors, silicon track trigger electronics boards, associated hardware, and firmware support is also included in the trigger upgrade project, as is the simulation effort. This summary WBS element includes all the effort required to develop, build, test, install, and initially commission these trigger elements.</div>																																											
1.2.1	Level 1 Calorimeter Trigger	1/2/02	2/7/05	\$456,521	\$921,727	\$6,680	\$1,384,928																																				
<div>Notes</div> <div>WBS Definition-</div> <div>This summary element covers the Level 1 calorimeter trigger modifications. It includes development and procurement of ADC/digital filter boards (ADF), development and procurement of trigger-algorithm boards (TAB), the provision of output signals to facilitate a match between calorimeter towers and tracks, and procurement and improvements in associated readout crates, power supplies, cabling, and controls hardware.</div>																																											
1.2.1.1	ADC/Digital Filter (ADF)	1/2/02	12/8/04	\$229,302	\$526,646	\$0	\$755,948																																				
<div>Notes</div> <div>WBS Definition-</div> <div>This summary element covers the design, fabrication and testing of the ADC+Digital filter cards which receive, digitize, and filter the calorimter tower signals</div> <div>Risk Mitigation (cost)-</div> <div>Risk of escalation in parts cost due to unforeseen design changes is mitigated by the relatively large contingency assigned to the procurement of components and fabrication/assembly given the advanced state of the design (prototype design nearly finished). Cost risk from extra labor needed to complete the project is reduced because of the large fraction of the labor that is covered by in-kind contributions from Saclay. Extra Saclay personnel can be diverted to the project should the need arise.</div>																																											
1.2.1.1.1	Design prototype ADF	1/2/02	11/22/02	\$0	\$189,656	\$0	\$189,656																																				
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>100%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>1,840 h</td><td>0 h</td><td>0 h</td><td>1,472 h</td><td>368 h</td></tr><tr><td>15</td><td>MandS</td><td>189,655.6</td><td>\$189,656</td><td>\$0</td><td>\$189,656</td><td>\$0</td><td>189,655.6</td><td></td><td>0</td><td>151,724.48</td><td>37,931.12</td></tr></table> <div>Notes</div> <div>WBS Definition-</div> <div>Design a 16- or 32-channel prototype ADC/digital filter card with all input, output and control connections.</div> <div>M&amp;S BOE-</div> <div>1840 h of Saclay engineer at \$4122.95/w = \$189,655.60</div> <div>Labor BOE-</div> <div>Based on effort expended on the project so far. Note that the design of the ADF prototype is almost entirely complete.</div>								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	100%	\$0	\$0	\$0	\$0	1,840 h	0 h	0 h	1,472 h	368 h	15	MandS	189,655.6	\$189,656	\$0	\$189,656	\$0	189,655.6		0	151,724.48	37,931.12
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
4	ElecEngU	100%	\$0	\$0	\$0	\$0	1,840 h	0 h	0 h	1,472 h	368 h																																
15	MandS	189,655.6	\$189,656	\$0	\$189,656	\$0	189,655.6		0	151,724.48	37,931.12																																
1.2.1.1.2	Layout prototype ADF	10/28/02	1/2/03	\$0	\$15,110	\$0	\$15,110																																				
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>8</td><td>ElecTechU</td><td>100%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>320 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>320 h</td></tr><tr><td>15</td><td>MandS</td><td>15,110.4</td><td>\$15,110</td><td>\$0</td><td>\$0</td><td>\$15,110</td><td>15,110.4</td><td></td><td>0</td><td>0</td><td>15,110.4</td></tr></table> <div>Notes</div> <div>WBS Definition-</div> <div>Layout prototype ADC boards</div> <div>M&amp;S BOE-</div> <div>320 h of Saclay engineer at \$1888.80/w = \$15,110.40</div> <div>Labor BOE-</div> <div>Estimate from lead engineer based on the current design of the ADF. Agrees well with the time needed to lay out boards of similar complexity in the STT system (4 weeks for the Fiber Road Card - FRC).</div>								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	8	ElecTechU	100%	\$0	\$0	\$0	\$0	320 h	0 h	0 h	0 h	320 h	15	MandS	15,110.4	\$15,110	\$0	\$0	\$15,110	15,110.4		0	0	15,110.4
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
8	ElecTechU	100%	\$0	\$0	\$0	\$0	320 h	0 h	0 h	0 h	320 h																																
15	MandS	15,110.4	\$15,110	\$0	\$0	\$15,110	15,110.4		0	0	15,110.4																																
1.2.1.1.3	Fabricate/Assemble Prototype ADF	1/3/03	2/28/03	\$52,500	\$7,555	\$0	\$60,055																																				
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>8</td><td>ElecTechU</td><td>50%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>160 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>160 h</td></tr><tr><td>15</td><td>MandS</td><td>60,055.2</td><td>\$60,055</td><td>\$0</td><td>\$0</td><td>\$60,055</td><td>60,055.2</td><td></td><td>0</td><td>0</td><td>60,055.2</td></tr></table> <div>Notes</div> <div>WBS Definition-</div>								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	8	ElecTechU	50%	\$0	\$0	\$0	\$0	160 h	0 h	0 h	0 h	160 h	15	MandS	60,055.2	\$60,055	\$0	\$0	\$60,055	60,055.2		0	0	60,055.2
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
8	ElecTechU	50%	\$0	\$0	\$0	\$0	160 h	0 h	0 h	0 h	160 h																																
15	MandS	60,055.2	\$60,055	\$0	\$0	\$60,055	60,055.2		0	0	60,055.2																																

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Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																																												
"Fabricate/Assemble Prototype ADF" continued																																																																			
	<u>Notes</u> Fabricate 5 prototype cards.  M&S BOE- \$52,500 for equipment (assumes prototypes are ~10x the cost of the production versions) plus 160 h Saclay technician at \$1888.80/w = \$7,555.20 ----- total = \$60,055.20  Labor BOE- Based on the Fab/Assembly time for the STT FRC (4 weeks). Multiplied by a factor of two to take into account increased board complexity.																																																																		
1.2.1.1.4	Bench Test Prototype ADF	2/3/03	5/2/03	\$5,000	\$15,632	\$0	\$20,632																																																												
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>20%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>104 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>104 h</td></tr><tr><td>8</td><td>ElecTechU</td><td>20%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>104 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>104 h</td></tr><tr><td>10</td><td>PhysicistU</td><td>30%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>156 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>156 h</td></tr><tr><td>15</td><td>MandS</td><td>20,632.24</td><td>\$20,632</td><td>\$0</td><td>\$0</td><td>\$20,632</td><td>20,632.24</td><td></td><td>0</td><td>0</td><td>20,632.24</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	20%	\$0	\$0	\$0	\$0	104 h	0 h	0 h	0 h	104 h	8	ElecTechU	20%	\$0	\$0	\$0	\$0	104 h	0 h	0 h	0 h	104 h	10	PhysicistU	30%	\$0	\$0	\$0	\$0	156 h	0 h	0 h	0 h	156 h	15	MandS	20,632.24	\$20,632	\$0	\$0	\$20,632	20,632.24		0	0	20,632.24						
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																								
4	ElecEngU	20%	\$0	\$0	\$0	\$0	104 h	0 h	0 h	0 h	104 h																																																								
8	ElecTechU	20%	\$0	\$0	\$0	\$0	104 h	0 h	0 h	0 h	104 h																																																								
10	PhysicistU	30%	\$0	\$0	\$0	\$0	156 h	0 h	0 h	0 h	156 h																																																								
15	MandS	20,632.24	\$20,632	\$0	\$0	\$20,632	20,632.24		0	0	20,632.24																																																								
	<u>Notes</u> WBS Definition- Test on test stand with simulated input signals.  M&S BOE- \$5,000 for test equipment (see cost book for details) plus 104 h Saclay engineer at \$4122.95/w = \$10,719.66 plus 104 h Saclay technician at \$1888.80/w = \$4,910.88 ----- total = \$20,630.54																																																																		
1.2.1.1.5	Prototype L1 Calorimeter Trigger ADF Shipped To	5/2/03	5/2/03	\$0	\$0	\$0	\$0																																																												
	<u>Notes</u> WBS Definition- milestone: at least one prototype shipped to Fermilab for in-situ tests																																																																		
1.2.1.1.6	Design analog splitter	3/1/02	3/28/02	\$0	\$16,494	\$0	\$16,494																																																												
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>100%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>160 h</td><td>0 h</td><td>0 h</td><td>160 h</td><td>0 h</td></tr><tr><td>15</td><td>MandS</td><td>16,494.4</td><td>\$16,494</td><td>\$0</td><td>\$16,494</td><td>\$0</td><td>16,494.4</td><td></td><td>0</td><td>16,494.4</td><td>0</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	100%	\$0	\$0	\$0	\$0	160 h	0 h	0 h	160 h	0 h	15	MandS	16,494.4	\$16,494	\$0	\$16,494	\$0	16,494.4		0	16,494.4	0																														
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																								
4	ElecEngU	100%	\$0	\$0	\$0	\$0	160 h	0 h	0 h	160 h	0 h																																																								
15	MandS	16,494.4	\$16,494	\$0	\$16,494	\$0	16,494.4		0	16,494.4	0																																																								
	<u>Notes</u> WBS Definition- This element is an active device that takes as input a number of differential analog signals coming from the BLS cards, and produces two identical copies of these signals. One copy feeds the trigger system in place (CTFE board) while the second copy is to be connected to the prototype ADF. The board accomodates 8 channels, i.e. 4 trigger towers. All channels are identical and comprises 3 fully-differential amplifiers and passive components. The complexity of the board is rather low.  M&S BOE- 160 h Saclay engineer at \$4122.95/w = \$16,491.79  Labor BOE- Design finished.																																																																		
1.2.1.1.7	Layout and fabricate analog splitter	7/1/02	8/26/02	\$1,595	\$7,555	\$0	\$9,150																																																												
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>8</td><td>ElecTechU</td><td>50%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>160 h</td><td>0 h</td><td>0 h</td><td>160 h</td><td>0 h</td></tr><tr><td>15</td><td>MandS</td><td>9,150.2</td><td>\$9,150</td><td>\$0</td><td>\$9,150</td><td>\$0</td><td>9,150.2</td><td></td><td>0</td><td>9,150.2</td><td>0</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	8	ElecTechU	50%	\$0	\$0	\$0	\$0	160 h	0 h	0 h	160 h	0 h	15	MandS	9,150.2	\$9,150	\$0	\$9,150	\$0	9,150.2		0	9,150.2	0																														
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																								
8	ElecTechU	50%	\$0	\$0	\$0	\$0	160 h	0 h	0 h	160 h	0 h																																																								
15	MandS	9,150.2	\$9,150	\$0	\$9,150	\$0	9,150.2		0	9,150.2	0																																																								
	<u>Notes</u> WBS Definition- Layout and fabrication of Splitter cards.  M&S BOE-																																																																		

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost				
"Layout and fabricate analog splitter" continued											
<u>Notes</u> \$1595 for components and fab costs (see cost book for details) 160 h Saclay technician at \$1888.80/w = \$7,555.20 ----- total = \$9,150.20  Labor BOE- Estimate from lead engineer based on completed design of the splitter card.											
1.2.1.1.8	Bench test analog splitter	9/4/02	9/17/02	\$0	\$1,889	\$0	\$1,889				
<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
8	ElecTechU	50%	\$0	\$0	\$0	\$0	40 h	0 h	0 h	40 h	0 h
15	MandS	1,888.8	\$1,889	\$0	\$1,889	\$0	1,888.8		0	1,888.8	0
<u>Notes</u> WBS Definition- Test of Splitter cards to verify basic functionality and to ensure that split signals are not degraded. Tests on a per channel basis include measurements of: gain vs frequency, dynamic range and temporal response under the expected input pulse shape.  M&S BOE- 40 h Saclay technician at \$1888.80/w = \$1,888.80  Labor BOE- Estimate of lead engineer based on his experience with similar, simple boards.											
1.2.1.1.9	Design SCL interface	7/15/02	9/23/02	\$0	\$41,236	\$0	\$41,236				
<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
4	ElecEngU	100%	\$0	\$0	\$0	\$0	400 h	0 h	0 h	360 h	40 h
15	MandS	41,236	\$41,236	\$0	\$41,236	\$0	41,236		0	37,112.4	4,123.6
<u>Notes</u> WBS Definition- This element is in charge of distributing timing signals to the ADF system and provides a path to distribute fast synchronous signals within the ADF system. The board includes a SCL mezzanine receiver card and is linked to each ADF crate via a medium speed cable (~64 Mbit/s). A single FPGA and additional logic (e.g. digital delay lines) are used on that board; No slow control interface is needed because all parameters are static. This board is of moderate complexity.  M&S BOE- 400 h Saclay engineer at \$4122.95/w = \$41,229.48  Labor BOE- Estimate of lead engineer based on discussions with the people who designed the SCL.											
1.2.1.1.10	Layout and fabricate SCL interface	10/1/02	11/25/02	\$3,644	\$7,555	\$0	\$11,199				
<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
8	ElecTechU	50%	\$0	\$0	\$0	\$0	160 h	0 h	0 h	0 h	160 h
15	MandS	11,199.2	\$11,199	\$0	\$0	\$11,199	11,199.2		0	0	11,199.2
<u>Notes</u> WBS Definition- Layout and fabrication of SCL interface cards.  M&S BOE- \$3644 for components and fab costs (see cost book for details) 160 h Saclay technician at \$1888.80/w = \$7,555.20 ----- total = \$11,199.20  Labor BOE- A similar amount of effort is assumed for this task as for the analog splitter. The small increase in board complexity is not expected to significantly increase fabrication/assembly turnaround time.											

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WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.1.1.11	Bench test SCL interface	11/26/02	1/3/03	\$0	\$3,778	\$0	\$3,778
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	8 ElecTechU 50% \$0 \$0 \$0 \$0 80 h 0 h 0 h 0 h 80 h						
	15 MandS 3,777.6 \$3,778 \$0 \$0 \$3,778 3,777.6 0 0 3,777.6						
	<u>Notes</u>						
	WBS Definition-						
	Test of SCL interface cards to verify basic functionality. Tests include the validation of the bi-directional link between the board and each ADF crate, and the correct distribution of timing and control signals via the SCL when the board is in-situ. Test with SCL signals is part of Prototype integration task.						
	M&S BOE-						
	80 h Saclay technician at \$1888.80/w = \$3,777.60						
	Labor BOE-						
	Estimate of lead engineer based on his experience with similar, simple boards.						
1.2.1.1.12	Develop in-situ exercising/debugging software	5/5/03	9/24/03	\$0	\$41,235	\$0	\$41,235
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 50% \$0 \$0 \$0 \$0 400 h 0 h 0 h 0 h 400 h						
	10 PhysicistU 50% \$0 \$0 \$0 \$0 400 h 0 h 0 h 0 h 400 h						
	15 MandS 41,234.93 \$41,235 \$0 \$0 \$41,235 41,234.93 0 0 41,234.93						
	<u>Notes</u>						
	WBS Definition-						
	Develop special in situ and diagnostic software that cycles the system at design speed and verifies that the hardware gets the right answer. This software is used to download FPGA configuration, load programmable parameters, read-back captured data (e.g. input and output of the digital filter), and perform various tests (e.g. feed output link with a pseudo-random pattern to verify output link independently of digital filter).						
	M&S BOE -						
	400 hours of engineering at \$4123.49/w = \$41234.93						
	Labor BOE-						
	Experience with similar software from existing L1cal						
1.2.1.1.13	ADF Prototype in-situ tests	5/19/03	9/10/03	\$0	\$9,896	\$0	\$9,896
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 15% \$0 \$0 \$0 \$0 96 h 0 h 0 h 0 h 96 h						
	10 PhysicistU 100% \$0 \$0 \$0 \$0 640 h 0 h 0 h 0 h 640 h						
	15 MandS 9,896.38 \$9,896 \$0 \$0 \$9,896 9,896.38 0 0 9,896.38						
	<u>Notes</u>						
	WBS Definition-						
	Perform parasitic tests with split-off signals from the run2a calorimeter trigger. Test performance of digital filter on different trigger towers in the calorimeter. Tests include the recording of pulse shapes on several channels, the validation of the digital filter algorithm with real input signals, the cross-check with calorimeter precision data recorded by D0 DAQ.						
	M&S BOE -						
	96 h of MSU engineering at \$4123.49/w = \$9,896.38						
	Labor BOE -						
	Estimate based on experience of lead engineer with digital filters and on experience understanding Run IIa L1Cal signals.						
1.2.1.1.14	Final ADF design	8/27/03	11/5/03	\$0	\$41,236	\$0	\$41,236
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 100% \$0 \$0 \$0 \$0 400 h 0 h 0 h 0 h 400 h						
	15 MandS 41,236 \$41,236 \$0 \$0 \$41,236 41,236 0 0 41,236						
	<u>Notes</u>						
	WBS Definition-						
	Update prototype design to address any shortcomings found in testing						
	M&S BOE-						
	400 hours of engineering at \$4122.95/w = \$41,229.48						
	Labor BOE-						

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Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost				
"Final ADF design" continued											
<u>Notes</u> 1/4 of the time foreseen for the design of the board; only small fixes expected to be done.											
1.2.1.1.15	Procure ADF components	11/6/03	1/28/04	\$114,523	\$4,124	\$0	\$118,647				
<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
4	ElecEngU	10%	\$0	\$0	\$0	\$0	40 h	0 h	0 h	0 h	40 h
15	MandS	118,646.8	\$118,647	\$0	\$0	\$118,647	118,646.8		0	0	118,646.8
<u>Notes</u> WBS Definition- Procure all components for production version of ADF (ADC's, FPGA's, etc.)  M&S BOE - \$114,523.20 in equipment ( see back up material) plus 40 h of university engineering at \$4123.49/w = \$4123.49 ----- total = \$118,646.69  Labor BOE- Average amount of time needed for procurement at Fermilab, based on experience of M. Johnson.											
1.2.1.1.16	Fabricate, Assemble 10% ADF	1/29/04	3/24/04	\$5,204	\$7,555	\$0	\$12,759				
<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
8	ElecTechU	50%	\$0	\$0	\$0	\$0	160 h	0 h	0 h	0 h	160 h
15	MandS	12,759.2	\$12,759	\$0	\$0	\$12,759	12,759.2		0	0	12,759.2
<u>Notes</u> WBS Definition- Preproduction run  M&S BOE - equipment \$5204 plus 160 hours of university technician time to follow the production at \$1888.80/w = \$7555.20 ----- total = \$12,759.20											
1.2.1.1.17	Bench test 10% ADF	3/25/04	5/19/04	\$0	\$18,409	\$0	\$18,409				
<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
4	ElecEngU	10%	\$0	\$0	\$0	\$0	32 h	0 h	0 h	0 h	32 h
8	ElecTechU	100%	\$0	\$0	\$0	\$0	320 h	0 h	0 h	0 h	320 h
10	PhysicistU	30%	\$0	\$0	\$0	\$0	96 h	0 h	0 h	0 h	96 h
15	MandS	18,409.28	\$18,409	\$0	\$0	\$18,409	18,409.28		0	0	18,409.28
<u>Notes</u> WBS Definition- Test first 10% of boards before approving full production run. Same tests as 1.2.1.1.13; additional tests with several ADF boards feeding a TAB.  M&S BOE - 320 h of university technician time @ \$1888.80/w = \$15,110.40 plus 32 h of university engineering time @ \$4123.49/w = \$3298.79 ----- total = \$18,409.19  Labor BOE- 1/2 the effort required for prototype testing (1.2.1.1.13).											
1.2.1.1.18	Fabricate production ADF	5/20/04	11/22/04	\$46,836	\$4,911	\$0	\$51,747				
<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
8	ElecTechU	10%	\$0	\$0	\$0	\$0	104 h	0 h	0 h	0 h	104 h
15	MandS	51,746.88	\$51,747	\$0	\$0	\$51,747	51,746.88		0	0	51,746.88

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost				
"Fabricate production ADF" continued											
<div>Notes</div> <div>WBS Definition- Fabricate remaining 90% of production ADF boards.</div> <div>M&amp;S BOE - \$46,836 in equipment, plus 104 h of univeristy technician time to follow production @ \$1888.8/w = \$4910.88 ----- total = \$51,746.88</div>											
1.2.1.1.19	Bench test production ADF	6/4/04	12/8/04	\$0	\$59,830	\$0	\$59,830				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngU	10%	\$0	\$0	\$0	\$0	104 h	0 h	0 h	0 h	104 h
8	ElecTechU	100%	\$0	\$0	\$0	\$0	1,040 h	0 h	0 h	0 h	1,040 h
10	PhysicistU	30%	\$0	\$0	\$0	\$0	312 h	0 h	0 h	0 h	312 h
15	MandS	59,830.16	\$59,830	\$0	\$0	\$59,830	59,830.16		0	0	59,830.16
<div>Notes</div> <div>WBS Definition- Same tests as for 1.2.1.1.17, but for final production boards.</div> <div>M&amp;S BOE - 1040 h of univeristy technician time at \$1888.8/w = \$49108.80 plus 104 h of university engineer time at \$4123.49/w = \$10721.08 ----- total = \$59,829.88</div> <div>Labor BOE- Further streamlining of testing assumed. At this stage all flaws in the design should be ironed out. Testing should be mainly to catch fabrication faults.</div>											
1.2.1.1.20	L1 Calorimeter Trigger ADF Production Complete /	12/8/04	12/8/04	\$0	\$0	\$0	\$0				
<div>Notes</div> <div>WBS Definition- milestone: All ADF cards ready for installation and commissioning</div>											
1.2.1.1.21	Digital filter FPGA programming	11/25/02	7/9/04	\$0	\$32,989	\$0	\$32,989				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngU	10%	\$0	\$0	\$0	\$0	320 h	0 h	0 h	0 h	320 h
10	PhysicistU	30%	\$0	\$0	\$0	\$0	960 h	0 h	0 h	0 h	960 h
15	MandS	32,988.8	\$32,989	\$0	\$0	\$32,989	32,988.8		0	0	32,988.8
<div>Notes</div> <div>WBS Definition- Develop digital filter algorithms based on simulations and results of ADF prototype.</div> <div>M&amp;S BOE - 320 h of Saclay engineering time at \$4122.95/w = \$32,983.58</div> <div>Labor BOE- Based on actual time taken for the completion and implementation of the prototype algorithm (8-tap FIR + 3 point peak detector + final Et look-up table).</div>											
1.2.1.1.22	ADF offline software and analysis	3/24/03	10/22/03	\$0	\$0	\$0	\$0				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	PhysicistU	50%	\$0	\$0	\$0	\$0	600 h	0 h	0 h	0 h	600 h
<div>Notes</div> <div>WBS definition - Write software for the offline analysis of the ADF data acquired in the in-situ test. These results are used to optimize the digital filter design.</div> <div>Labor BOE - 50% of a physicists is needed for the duration of the task. Preparation must start 8 weeks before the in-situ test begin, and continue six weeks after the test are complete in order to analyze the data taken.</div>											

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost					
1.2.1.2	ADF Crates	10/14/02	11/19/03	\$53,700	\$68,800	\$0	\$122,500					
<div>Notes</div> <div>WBS Definition- Design 6u VME crates with a (probably) custom J2 backplane</div>												
1.2.1.2.1	Design transition backplane	10/14/02	11/22/02	\$0	\$24,742	\$0	\$24,742					
	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
	4	ElecEngU	100%	\$0	\$0	\$0	\$0	240 h	0 h	0 h	0 h	240 h
	15	MandS	24,741.6	\$24,742	\$0	\$0	\$24,742	24,741.6		0	0	24,741.6
<div>Notes</div> <div>WBS Definition- Design custom backplane for ADF crates. This element is used to bring 640 differential analog signals to the 20 ADF boards that are housed in each ADF crate. The passive custom backplane comprises 320 8-point connectors on the BLS cable side, and 20 96 or 160-point connectors on the VME backplane side. Trivial design from electronics point of view; minor mechanical issues; controlled impedance lines needed for the PCB.  M&amp;S BOE- 240 h of Saclay engineering time at \$4122.95/w = \$24,737.69  Labor BOE- Estimate from lead engineer based on scope of backplane.</div>												
1.2.1.2.2	Layout and fabricate transition backplane	12/2/02	2/5/03	\$0	\$7,555	\$0	\$7,555					
	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
	8	ElecTechU	50%	\$0	\$0	\$0	\$0	160 h	0 h	0 h	0 h	160 h
	15	MandS	7,555.2	\$7,555	\$0	\$0	\$7,555	7,555.2		0	0	7,555.2
<div>Notes</div> <div>WBS Definition- Layout and fabrication of transition backplanes.  M&amp;S BOE- \$0 for components and fab costs (reuse material at lab) 160 h Saclay technician at \$1888.80/w = \$7,555.20 ----- total = \$7,555.20  Labor BOE- Estimate from lead engineer based on complexity of design.</div>												
1.2.1.2.3	Fabricate/Assemble Prototype crate	2/6/03	4/2/03	\$0	\$7,555	\$0	\$7,555					
	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
	8	ElecTechU	50%	\$0	\$0	\$0	\$0	160 h	0 h	0 h	0 h	160 h
	15	MandS	7,555.2	\$7,555	\$0	\$0	\$7,555	7,555.2		0	0	7,555.2
<div>Notes</div> <div>WBS Definition- Assemble prototype ADF crate from material at lab.  M&amp;S BOE- \$0 for components and fab costs (reuse material at lab) 160 h Saclay technician at \$1888.80/w = \$7,555.20 ----- total = \$7,555.20  Labor BOE- Based on time required to fabricate/assemble custom backplane for STT system (~1 month).</div>												
1.2.1.2.4	Test prototype crate ADF in prototype crate	4/3/03	5/29/03	\$0	\$9,620	\$0	\$9,620					
	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
	4	ElecEngU	20%	\$0	\$0	\$0	\$0	64 h	0 h	0 h	0 h	64 h
	8	ElecTechU	20%	\$0	\$0	\$0	\$0	64 h	0 h	0 h	0 h	64 h
	10	PhysicistU	30%	\$0	\$0	\$0	\$0	96 h	0 h	0 h	0 h	96 h

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Test prototype crate ADF in prototype crate" continued							
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	15 MandS 9,619.84 \$9,620 \$0 \$0 \$9,620 9,619.84 0 0 9,619.84						
	<i>Notes</i>						
	WBS Definition-						
	Test prototype ADF cards in prototype crate. Feed ADF prototyte board with analog signals via prototype backplane. Measure signal degradation (expected to be negligible).						
	M&S BOE-						
	64 h Saclay engineer at \$4122.95/w = \$6,596.72 plus						
	64 h Saclay technician at \$1888.80/w = \$3,022.08						
	-----						
	total = \$9,618.80						
	Labor BOE-						
	Estimate from lead engineer. Testing time comparable to that of testing analog splitter cards.						
1.2.1.2.5	L1 Calorimeter Trigger ADF+Crate Prototype Comp	5/29/03	5/29/03	\$0	\$0	\$0	\$0
	<i>Notes</i>						
	WBS Definition-						
	milestone						
1.2.1.2.6	Final backplane design	9/11/03	10/8/03	\$0	\$16,494	\$0	\$16,494
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 100% \$0 \$0 \$0 \$0 160 h 0 h 0 h 0 h 160 h						
	15 MandS 16,494.4 \$16,494 \$0 \$0 \$16,494 16,494.4 0 0 16,494.4						
	<i>Notes</i>						
	WBS Definition-						
	Update prototype design to address any shortcomings found in testing.						
	M&S BOE-						
	160 hours of engineering at \$4122.95/w = \$16,491.79						
	Labor BOE-						
	Estimate from lead engineer. Taken to be same as time for initial design (1.2.1.2.1).						
1.2.1.2.7	Procure crate components	10/9/03	11/12/03	\$50,200	\$944	\$0	\$51,144
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	8 ElecTechU 100% \$0 \$0 \$0 \$0 20 h 0 h 0 h 0 h 20 h						
	15 MandS 51,144.44 \$51,144 \$0 \$0 \$51,144 51,144.44 0 0 51,144.44						
	<i>Notes</i>						
	WBS Definition-						
	Procure backplanes, power supplies, and mechanical parts.						
	M&S BOE -						
	Equipment at \$50,200.						
	20 hours of university electrical technican to research and place orders, @ \$1888.80/w = \$944.40						
	-----						
	total = \$51,144.40						
	Labor BOE-						
	Estimate from lead engineer						
1.2.1.2.8	Assemble ADF crates	11/13/03	11/19/03	\$3,500	\$1,889	\$0	\$5,389
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	8 ElecTechU 100% \$0 \$0 \$0 \$0 40 h 0 h 0 h 0 h 40 h						
	15 MandS 5,388.8 \$5,389 \$0 \$0 \$5,389 5,388.8 0 0 5,388.8						
	<i>Notes</i>						
	WBS Definition-						
	Assemble all production crates						



WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																				
"Assemble ADF crates" continued																																											
	<u>Notes</u>  M&S BOE - backplane fabrication & assembly = \$3,500, plus 40 h of university electrical tech @ 1888.80/w = \$1888.80 ----- total = \$5,388.80  Labor BOE- Similar to 1.2.1.2.3.																																										
1.2.1.3	Trigger Algorithm Board	2/1/02	10/18/04	\$109,038	\$155,732	\$0	\$264,770																																				
	<u>Notes</u> WBS Definition- This summary element covers the algorithm board which receives the filtered tower transverse energies from the ADF boards and finds jet, EM and tau clusters.  Risk Mitigation (cost)- Risk of escalation in parts cost due to unforeseen design changes is mitigated by the relatively large contingency assigned to the procurement of components and fabrication/assembly given the advanced state of the design (prototype layout started). Cost risk from extra labor needed to complete the project is reduced because of the large fraction of the labor that is covered by in-kind contributions from Columbia/Nevis. Extra Nevis personnel can be diverted to the project should the need arise.																																										
1.2.1.3.1	Choose L1 Calorimeter Trigger Baseline Jet Algori	8/8/02	8/8/02	\$0	\$0	\$0	\$0																																				
	<u>Notes</u> WBS Definition- Milestone: Establish baseline jet cluster algorithm that will be used to specify the prototype TAB.																																										
1.2.1.3.2	Design prototype Trigger Algorithm Board (TAB)	2/1/02	10/1/02	\$0	\$93,110	\$0	\$93,110																																				
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>74%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>999.6 h</td><td>0 h</td><td>0 h</td><td>799.68 h</td><td>199.92 h</td></tr><tr><td>15</td><td>MandS</td><td>93,110</td><td>\$93,110</td><td>\$0</td><td>\$93,110</td><td>\$0</td><td>93,110</td><td></td><td>0</td><td>74,488</td><td>18,622</td></tr></table> <u>Notes</u> WBS Definition- Design a full prototype trigger algorithm board with all input, output and control connections.  M&S BOE- 1000 h of Columbia engineering at \$3724.40/w = \$93,110.00  Labor BOE- Estimated from progress so far.							ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	74%	\$0	\$0	\$0	\$0	999.6 h	0 h	0 h	799.68 h	199.92 h	15	MandS	93,110	\$93,110	\$0	\$93,110	\$0	93,110		0	74,488	18,622
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
4	ElecEngU	74%	\$0	\$0	\$0	\$0	999.6 h	0 h	0 h	799.68 h	199.92 h																																
15	MandS	93,110	\$93,110	\$0	\$93,110	\$0	93,110		0	74,488	18,622																																
1.2.1.3.3	Layout prototype TAB	8/9/02	10/4/02	\$0	\$8,533	\$0	\$8,533																																				
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>29%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>92 h</td><td>0 h</td><td>0 h</td><td>46 h</td><td>46 h</td></tr><tr><td>15</td><td>MandS</td><td>8,532.8</td><td>\$8,533</td><td>\$0</td><td>\$8,533</td><td>\$0</td><td>8,532.8</td><td></td><td>0</td><td>4,266.4</td><td>4,266.4</td></tr></table> <u>Notes</u> WBS Definition- Layout of prototype TAB proceeds in parallel with design because of large number of signals to be routed.  M&S BOE - 92 hours of Columbia engineering at \$3724.40/w = \$8,566.12  Labor BOE- Based on layout time for Run 2a Silicon Track Trigger (STT) Fiber Road Card (FRC) - 4 weeks. Multiplied by a factor of 2 to account for increased board complexity.							ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	29%	\$0	\$0	\$0	\$0	92 h	0 h	0 h	46 h	46 h	15	MandS	8,532.8	\$8,533	\$0	\$8,533	\$0	8,532.8		0	4,266.4	4,266.4
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
4	ElecEngU	29%	\$0	\$0	\$0	\$0	92 h	0 h	0 h	46 h	46 h																																
15	MandS	8,532.8	\$8,533	\$0	\$8,533	\$0	8,532.8		0	4,266.4	4,266.4																																
1.2.1.3.4	Procure prototype TAB parts	8/23/02	11/1/02	\$15,798	\$2,133	\$0	\$17,931																																				
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>8</td><td>ElecTechU</td><td>10%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>40 h</td><td>0 h</td><td>0 h</td><td>30 h</td><td>10 h</td></tr><tr><td>15</td><td>MandS</td><td>17,931.2</td><td>\$17,931</td><td>\$0</td><td>\$17,931</td><td>\$0</td><td>17,931.2</td><td></td><td>0</td><td>13,448.4</td><td>4,482.8</td></tr></table>							ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	8	ElecTechU	10%	\$0	\$0	\$0	\$0	40 h	0 h	0 h	30 h	10 h	15	MandS	17,931.2	\$17,931	\$0	\$17,931	\$0	17,931.2		0	13,448.4	4,482.8
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
8	ElecTechU	10%	\$0	\$0	\$0	\$0	40 h	0 h	0 h	30 h	10 h																																
15	MandS	17,931.2	\$17,931	\$0	\$17,931	\$0	17,931.2		0	13,448.4	4,482.8																																

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																																																								
"Procure prototype TAB parts" continued																																																																															
<div>Notes</div> <div>WBS Definition- Procure all parts for prototype of TAB cards.</div> <div>M&amp;S BOE- \$15798 for equipment. Details of the components going into this cost estimate are available in the supporting material folder. plus 40 hours of university technician to carry out procurement at \$2133.33/w = \$2133.33 ----- total = \$17,931.33</div> <div>Labor BOE- Average amount of effort needed for procurement at Fermilab, based on experience of M. Johnson. Time required based on experience with long lead-time electronics purchases.</div>																																																																															
1.2.1.3.5	Fabricate/Assemble Prototype TAB	11/4/02	1/9/03	\$10,000	\$1,707	\$0	\$11,707																																																																								
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>8</td><td>ElecTechU</td><td>10%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>32 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>32 h</td></tr><tr><td>15</td><td>MandS</td><td>11,706.56</td><td>\$11,707</td><td>\$0</td><td>\$0</td><td>\$11,707</td><td>11,706.56</td><td></td><td>0</td><td>0</td><td>11,706.56</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	8	ElecTechU	10%	\$0	\$0	\$0	\$0	32 h	0 h	0 h	0 h	32 h	15	MandS	11,706.56	\$11,707	\$0	\$0	\$11,707	11,706.56		0	0	11,706.56																																										
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																																				
8	ElecTechU	10%	\$0	\$0	\$0	\$0	32 h	0 h	0 h	0 h	32 h																																																																				
15	MandS	11,706.56	\$11,707	\$0	\$0	\$11,707	11,706.56		0	0	11,706.56																																																																				
<div>Notes</div> <div>WBS Definition- Fabricate two prototype cards.</div> <div>M&amp;S BOE - 10,000 for fabrificaion and assembly, plus 32 hours of university technician at \$2133.33/w = \$1,706.66 ----- total = \$11706.66</div> <div>Labor BOE- Based on Fab/Assembly time for STT FRC - 4 weeks. Multiplied by a factor of 2 to account for increased board complexity.</div>																																																																															
1.2.1.3.6	Develop TAB/GAB test software	11/4/02	11/19/03	\$0	\$0	\$0	\$0																																																																								
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>13</td><td>StudentU</td><td>10%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>208 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>208 h</td></tr><tr><td>14</td><td>PostdocU</td><td>10%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>208 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>208 h</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	13	StudentU	10%	\$0	\$0	\$0	\$0	208 h	0 h	0 h	0 h	208 h	14	PostdocU	10%	\$0	\$0	\$0	\$0	208 h	0 h	0 h	0 h	208 h																																										
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																																				
13	StudentU	10%	\$0	\$0	\$0	\$0	208 h	0 h	0 h	0 h	208 h																																																																				
14	PostdocU	10%	\$0	\$0	\$0	\$0	208 h	0 h	0 h	0 h	208 h																																																																				
<div>Notes</div> <div>WBS Definition- Write software necessary for testing the prototype and production TAB and GAB cards.</div> <div>M&amp;S BOE- n/a</div> <div>Labor BOE- Based on the amount of effort required to write similar software for the STT FRCs, cards which have a similar number of functions to be tested.</div>																																																																															
1.2.1.3.7	Test prototype TAB	1/10/03	5/16/03	\$0	\$15,328	\$0	\$15,328																																																																								
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>20%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>144 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>144 h</td></tr><tr><td>8</td><td>ElecTechU</td><td>5%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>36 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>36 h</td></tr><tr><td>10</td><td>PhysicistU</td><td>20%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>144 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>144 h</td></tr><tr><td>13</td><td>StudentU</td><td>50%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>360 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>360 h</td></tr><tr><td>15</td><td>MandS</td><td>15,327.72</td><td>\$15,328</td><td>\$0</td><td>\$0</td><td>\$15,328</td><td>15,327.72</td><td></td><td>0</td><td>0</td><td>15,327.72</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	20%	\$0	\$0	\$0	\$0	144 h	0 h	0 h	0 h	144 h	8	ElecTechU	5%	\$0	\$0	\$0	\$0	36 h	0 h	0 h	0 h	36 h	10	PhysicistU	20%	\$0	\$0	\$0	\$0	144 h	0 h	0 h	0 h	144 h	13	StudentU	50%	\$0	\$0	\$0	\$0	360 h	0 h	0 h	0 h	360 h	15	MandS	15,327.72	\$15,328	\$0	\$0	\$15,328	15,327.72		0	0	15,327.72						
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																																				
4	ElecEngU	20%	\$0	\$0	\$0	\$0	144 h	0 h	0 h	0 h	144 h																																																																				
8	ElecTechU	5%	\$0	\$0	\$0	\$0	36 h	0 h	0 h	0 h	36 h																																																																				
10	PhysicistU	20%	\$0	\$0	\$0	\$0	144 h	0 h	0 h	0 h	144 h																																																																				
13	StudentU	50%	\$0	\$0	\$0	\$0	360 h	0 h	0 h	0 h	360 h																																																																				
15	MandS	15,327.72	\$15,328	\$0	\$0	\$15,328	15,327.72		0	0	15,327.72																																																																				
<div>Notes</div> <div>WBS Definition- Test in test stand to verify that simulated inputs produce correct outputs for all of TAB functions: EM, jet, tau cluster finding, partial global sums, Cal-Trk match output, L2/L3 output.</div> <div>M&amp;S BOE - 144 hours of Columbia engineer at \$3724.40/w = \$13407.84 plus 36 hours of Columbia technician at \$2133.33/w = \$1920.00</div>																																																																															

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Test prototype TAB" continued							
	<u>Notes</u>						
	total = \$15,327.84						
	Labor BOE-						
	Based on the amount of effort required to test the STT FRC and BC cards before they could be submitted for production. The complexity of the TAB is similar to that of the FRC and BC taken together.						
<b>1.2.1.3.8</b>	<b>L1 Calorimeter Trigger TAB Prototype Complete</b>	<b>5/16/03</b>	<b>5/16/03</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
	<u>Notes</u>						
	WBS Definition-						
	Milestone: TAB prototype complete and passes bench tests: produces all the correct outputs for known inputs or failures understood.						
1.2.1.3.9	Pre-production TAB design	10/10/03	11/6/03	\$0	\$2,980	\$0	\$2,980
	<u>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</u>						
	4 ElecEngU 20% \$0 \$0 \$0 \$0 32 h 0 h 0 h 0 h 32 h						
	15 MandS 2,979.62 \$2,980 \$0 \$0 \$2,980 2,979.62 0 0 0 2,979.62						
	<u>Notes</u>						
	WBS Definition-						
	Update prototype design to address any shortcomings found in testing. This process will occur largely in parallel with the TAB prototype testing.						
	M&S BOE -						
	32 hours of Columbia engineer at \$3274.40/w = \$2,979.52						
	Labor BOE-						
	Estimated from time required to implement final changes to FRC design after testing.						
1.2.1.3.10	Procure TAB parts	11/7/03	1/29/04	\$58,240	\$2,133	\$0	\$60,373
	<u>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</u>						
	8 ElecTechU 10% \$0 \$0 \$0 \$0 40 h 0 h 0 h 0 h 40 h						
	15 MandS 60,373.2 \$60,373 \$0 \$0 \$60,373 60,373.2 0 0 0 60,373.2						
	<u>Notes</u>						
	WBS Definition-						
	Procure all parts for production of TAB cards.						
	M&S BOE-						
	Details of the components going into this cost estimate are available in the supporting material folder.						
	Equipment = \$58,240, plus						
	40 hours of electrical technician at \$2133.33/w = \$2133.33						
	total = \$60,373.33						
	Labor BOE-						
	Average amount of effort needed for procurement at Fermilab, based on experience of M. Johnson. Time required based on experience with long lead-time electronics purchases.						
1.2.1.3.11	Layout pre-production TAB	11/7/03	12/22/03	\$0	\$11,173	\$0	\$11,173
	<u>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</u>						
	4 ElecEngU 50% \$0 \$0 \$0 \$0 120 h 0 h 0 h 0 h 120 h						
	15 MandS 11,173.2 \$11,173 \$0 \$0 \$11,173 11,173.2 0 0 0 11,173.2						
	<u>Notes</u>						
	WBS Definition-						
	Lay out final design for TAB cards.						
	M&S BOE -						
	120 hours of Columbia engineer at \$3724.40/w = \$11,173.20						
	Labor BOE-						
	Based on layout time for final STT FRC - 3 weeks. Multiplied by a factor of 2 to account for increased board complexity.						

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.1.3.12	Fabricate/Assemble pre-production TAB	12/23/03	2/26/04	\$10,000	\$1,707	\$0	\$11,707
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	8 ElecTechU 10% \$0 \$0 \$0 \$0 32 h 0 h 0 h 0 h 32 h						
	15 MandS 11,706.56 \$11,707 \$0 \$0 \$11,707 11,706.56 0 0 0 11,706.56						
	<u>Notes</u>						
	WBS Definition-						
	Fabricate and assemble 2 TABs with final design.						
	M&S BOE -						
	\$10,000 in equipment, plus						
	32 hours of university electrical tech at \$2133.33/w = \$1,706.66						
	-----						
	total = \$11,706.66						
	Labor BOE-						
	Based on Fab/Assembly time for STT FRC - 4 weeks. Multiplied by a factor of 2 to account for increased board complexity.						
1.2.1.3.13	Bench test pre-production TAB	2/27/04	4/8/04	\$0	\$7,984	\$0	\$7,984
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 30% \$0 \$0 \$0 \$0 72 h 0 h 0 h 0 h 72 h						
	8 ElecTechU 10% \$0 \$0 \$0 \$0 24 h 0 h 0 h 0 h 24 h						
	10 PhysicistU 30% \$0 \$0 \$0 \$0 72 h 0 h 0 h 0 h 72 h						
	13 StudentU 75% \$0 \$0 \$0 \$0 180 h 0 h 0 h 0 h 180 h						
	15 MandS 7,983.84 \$7,984 \$0 \$0 \$7,984 7,983.84 0 0 7,983.84						
	<u>Notes</u>						
	WBS Definition-						
	Repeat prototype bench tests for pre-production boards.						
	M&S BOE -						
	72 hours of Columbia electrical engineer at \$3724.40/w = \$6,703.92, plus						
	24 hour of Columbia electrical tech at \$2133.33/w = \$1,280.00						
	-----						
	total = \$7,983.92						
	Labor BOE-						
	Based on test time for first production STT FRC. Multiplied by a factor of 2 to account for increased board complexity.						
1.2.1.3.14	Final design and layout changes to TAB	5/13/04	5/26/04	\$0	\$3,724	\$0	\$3,724
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 50% \$0 \$0 \$0 \$0 40 h 0 h 0 h 0 h 40 h						
	15 MandS 3,724.4 \$3,724 \$0 \$0 \$3,724 3,724.4 0 0 3,724.4						
	<u>Notes</u>						
	WBS Definition-						
	Final changes to TAB design and layout based on pre-prod tests. Much of this will happen as the testing proceeds.						
	M&S BOE -						
	40 hours of Columbia engineer at \$3724.40/w = \$3,724.40						
	Labor BOE-						
	Based on changes necessary at the last stage of the STT FRC production. Multiplied by a factor of 2 to take into account increased board complexity.						
1.2.1.3.15	Fabricate production TAB	5/27/04	7/23/04	\$15,000	\$1,707	\$0	\$16,707
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	8 ElecTechU 10% \$0 \$0 \$0 \$0 32 h 0 h 0 h 0 h 32 h						
	15 MandS 16,706.56 \$16,707 \$0 \$0 \$16,707 16,706.56 0 0 16,706.56						
	<u>Notes</u>						
	WBS Definition-						
	Fabricate and assemble production TAB						
	M&S BOE -						

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																																												
"Fabricate production TAB" continued																																																																			
<div>Notes</div> <div>equipment = \$15,000 plus 32 hours of university technician at \$2133.33/w = \$1,706.66 ----- total = \$16,706.66</div>																																																																			
1.2.1.3.16	Bench test production TAB	7/26/04	10/18/04	\$0	\$3,515	\$0	\$3,515																																																												
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>5%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>24 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>24 h</td></tr><tr><td>8</td><td>ElecTechU</td><td>5%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>24 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>24 h</td></tr><tr><td>13</td><td>StudentU</td><td>20%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>96 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>96 h</td></tr><tr><td>15</td><td>MandS</td><td>3,514.56</td><td>\$3,515</td><td>\$0</td><td>\$0</td><td>\$3,515</td><td>3,514.56</td><td></td><td>0</td><td>0</td><td>3,514.56</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	5%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h	8	ElecTechU	5%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h	13	StudentU	20%	\$0	\$0	\$0	\$0	96 h	0 h	0 h	0 h	96 h	15	MandS	3,514.56	\$3,515	\$0	\$0	\$3,515	3,514.56		0	0	3,514.56						
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																								
4	ElecEngU	5%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h																																																								
8	ElecTechU	5%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h																																																								
13	StudentU	20%	\$0	\$0	\$0	\$0	96 h	0 h	0 h	0 h	96 h																																																								
15	MandS	3,514.56	\$3,515	\$0	\$0	\$3,515	3,514.56		0	0	3,514.56																																																								
<div>Notes</div> <div>WBS Definition- Test full functionality of production boards at Nevis labs. Using simulated inputs, verify that all outputs of the board are as expected and that bit error rate in outputs acceptable -corresponding to approximately 1 fatal error per day at the nominal data volume.  M&amp;S BOE - 24 hours of Columbia electrical engineer at \$3724.40/w = \$2,234.64 plus 24 hours of Columbia technician at \$2133.33/w = \$1,280.00 ----- total = \$3,514.64  Labor BOE- Based on experience in testing final STT FRCs. Assume 1 week continuous tests per board (10 boards) + 2 weeks general tests and setup</div>																																																																			
1.2.1.4	Global Algorithm Board (GAB)	7/29/02	2/7/05	\$20,000	\$96,964	\$0	\$116,964																																																												
<div>Notes</div> <div>WBS Definition- This summary element covers the Global Algorithm Board which receives cluster information from the TAB's, performs final counts jets, EM and tau clusters above specified thresholds, calculates global sums (Et and missing Et) from TAB sums and exports trigger decisions to the TFW. The GAB also provides an interface and fanout for timing and control signal from the trigger framework for the TABs.</div>																																																																			
1.2.1.4.1	Design prototype GAB	7/29/02	11/18/02	\$0	\$59,590	\$0	\$59,590																																																												
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>100%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>208 h</td><td>0 h</td><td>0 h</td><td>112 h</td><td>96 h</td></tr><tr><td>15</td><td>MandS</td><td>59,590.4</td><td>\$59,590</td><td>\$0</td><td>\$59,590</td><td>\$0</td><td>59,590.4</td><td></td><td>0</td><td>14,897.6</td><td>44,692.8</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	100%	\$0	\$0	\$0	\$0	208 h	0 h	0 h	112 h	96 h	15	MandS	59,590.4	\$59,590	\$0	\$59,590	\$0	59,590.4		0	14,897.6	44,692.8																														
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																								
4	ElecEngU	100%	\$0	\$0	\$0	\$0	208 h	0 h	0 h	112 h	96 h																																																								
15	MandS	59,590.4	\$59,590	\$0	\$59,590	\$0	59,590.4		0	14,897.6	44,692.8																																																								
<div>Notes</div> <div>WBS Definition- Design a full prototype of the GAB.  M&amp;S BOE - 640 hours of Columbia engineer at \$3724.40/w = \$59,590.40  Labor BOE- Estimated from time required to design prototype STT FRC and BC. These boards have similar functionality to that required for the GAB.</div>																																																																			
1.2.1.4.2	Layout prototype GAB	11/19/02	12/18/02	\$0	\$7,449	\$0	\$7,449																																																												
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>50%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>80 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>80 h</td></tr><tr><td>15</td><td>MandS</td><td>7,448.8</td><td>\$7,449</td><td>\$0</td><td>\$0</td><td>\$7,449</td><td>7,448.8</td><td></td><td>0</td><td>0</td><td>7,448.8</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	50%	\$0	\$0	\$0	\$0	80 h	0 h	0 h	0 h	80 h	15	MandS	7,448.8	\$7,449	\$0	\$0	\$7,449	7,448.8		0	0	7,448.8																														
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																								
4	ElecEngU	50%	\$0	\$0	\$0	\$0	80 h	0 h	0 h	0 h	80 h																																																								
15	MandS	7,448.8	\$7,449	\$0	\$0	\$7,449	7,448.8		0	0	7,448.8																																																								
<div>Notes</div> <div>WBS Definition- Lay out prototype design for GAB.  M&amp;S BOE - 80 hours of Columbia engineer at \$3724.40/w = \$7,448.80  Labor BOE- Based on layout time for STT FRC - 4 weeks.</div>																																																																			

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.1.4.3	Procure prototype GAB parts	12/5/02	2/24/03	\$7,500	\$2,133	\$0	\$9,633
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	8 ElecTechU 10% \$0 \$0 \$0 \$0 40 h 0 h 0 h 0 h 40 h						
	15 MandS 9,633.2 \$9,633 \$0 \$0 \$9,633 9,633.2 0 0 0 9,633.2						
	<i>Notes</i>						
	WBS Definition- Procure all parts for prototype of GAB cards.						
	M&S BOE- Costs for the prototype GAB are based on STT FRC cost including motherboard, BC and Link Transmitter Board. FRC costs have been multiplied by a factor of 3 to take into account the small quantity purchases required here. These components cover the basic functionality required of the GAB. Details of the components going into this cost estimate are available in the supporting material folder. Contingency is assigned based on the conceptual nature of the current GAB design.						
	Equipment cost = \$7500, plus 40 hours of a university technician at \$2133.33/w = \$2133.33 ----- total = \$9,633.33						
	Labor BOE- Average amount of effort needed for procurement at Fermilab, based on experience of M. Johnson. Time required based on experience with long lead-time electronics purchases.						
1.2.1.4.4	Farbricate/Assemble Prototype GAB	2/25/03	3/24/03	\$4,500	\$853	\$0	\$5,353
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	8 ElecTechU 10% \$0 \$0 \$0 \$0 16 h 0 h 0 h 0 h 16 h						
	15 MandS 5,353.28 \$5,353 \$0 \$0 \$5,353 5,353.28 0 0 0 5,353.28						
	<i>Notes</i>						
	WBS Definition- Fabricate one prototype card.						
	M&S BOE - equipment = \$4,500, plus 16 hours of university electrical technician at \$2133.33/w = \$853.33 ----- total = \$5,353.33						
	Labor BOE- Based on Fab/Assembly time for STT FRC - 4 weeks.						
1.2.1.4.5	Test Prototype GAB	3/25/03	7/16/03	\$0	\$7,666	\$0	\$7,666
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 10% \$0 \$0 \$0 \$0 64 h 0 h 0 h 0 h 64 h						
	8 ElecTechU 5% \$0 \$0 \$0 \$0 32 h 0 h 0 h 0 h 32 h						
	10 PhysicistU 10% \$0 \$0 \$0 \$0 64 h 0 h 0 h 0 h 64 h						
	13 StudentU 25% \$0 \$0 \$0 \$0 160 h 0 h 0 h 0 h 160 h						
	15 MandS 7,665.6 \$7,666 \$0 \$0 \$7,666 7,665.6 0 0 0 7,665.6						
	<i>Notes</i>						
	WBS Definition- Test prototype GAB by sending control signals to prototype TAB, receiving cluster information from TAB and producing the correct TFW output. Task is only complete when full TAB functionality has also been tested.						
	M&S BOE - 64 hours of Columbia engineer at \$3724.40/w = \$5,959.04 plus 32 hours of Columbia electrical tech at \$2133.33/w = \$1,706.66 ----- total = \$7,665.70						
	Labor BOE- Based on the amount of effort required to integrate the STT FRC and BC cards. Multiplied by a factor of 2 to account for increased complexity.						

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.1.4.6	L1 Calorimeter Trigger GAB Prototype Complete	7/16/03	7/16/03	\$0	\$0	\$0	\$0
<div>Notes</div> <div>WBS Definition- Milestone. GAB prototype complete and passes bench tests: produces all the correct outputs for known inputs or failures understood.</div>							
1.2.1.4.7	Final GAB design	10/10/03	11/6/03	\$0	\$2,980	\$0	\$2,980
	IDResource NameUnitsCostBaseline CostAct. CostRem. CostWorkOvt. WorkBaseline WorkAct. WorkRem. Work						
	4ElecEngU20%\$0\$0\$0\$032 h0 h0 h0 h32 h						
	15MandS2,979.52\$2,980\$0\$0\$2,9802,979.52002,979.52						
<div>Notes</div> <div>WBS Definition- Update prototype design to address any shortcomings found in testing.</div> <div>M&amp;S BOE- 32 hours of Columbia engineer at \$3724.40/w = \$2,979.52</div> <div>Labor BOE- Estimated from time required to implement final changes to FRC design after testing.</div>							
1.2.1.4.8	Procure GAB parts	11/7/03	1/29/04	\$5,000	\$2,133	\$0	\$7,133
	IDResource NameUnitsCostBaseline CostAct. CostRem. CostWorkOvt. WorkBaseline WorkAct. WorkRem. Work						
	8ElecTechU10%\$0\$0\$0\$040 h0 h0 h0 h40 h						
	15MandS7,133.2\$7,133\$0\$0\$7,1337,133.2007,133.2						
<div>Notes</div> <div>WBS Definition- Procure all parts for production of GAB cards.</div> <div>M&amp;S BOE- Costs for the prototype GAB are based on STT FRC cost including motherboard, BC and Link Transmitter Board. These components cover the basic functionality required of the GAB. Details of the components going into this cost estimate are available in the supporting material folder. Contingency is assigned based on the conceptual nature of the current GAB design.</div> <div>Parts for 2 boards = \$5,000 plus 40 hour of university eletrical technician @ \$2133.33/w = \$2133.33 ----- total \$7,133.33</div> <div>Labor BOE- Average amount of effort needed for procurement at Fermilab, based on experience of M. Johnson. Time required based on experience with long lead-time electronics purchases.</div>							
1.2.1.4.9	Layout final GAB	11/7/03	12/22/03	\$0	\$4,469	\$0	\$4,469
	IDResource NameUnitsCostBaseline CostAct. CostRem. CostWorkOvt. WorkBaseline WorkAct. WorkRem. Work						
	4ElecEngU20%\$0\$0\$0\$048 h0 h0 h0 h48 h						
	15MandS4,469.28\$4,469\$0\$0\$4,4694,469.28004,469.28						
<div>Notes</div> <div>WBS Definition- Lay out final design for TAB cards.</div> <div>M&amp;S BOE - 48 hours of Columbia engineer at \$3724.40/w = \$4,469.28</div> <div>Labor BOE- Based on layout time for final STT FRC - 3 weeks. Schedule extended to 6 weeks to take into account parallel work on TAB.</div>							
1.2.1.4.10	Fabricate production GAB	10/19/04	12/15/04	\$3,000	\$1,707	\$0	\$4,707
	IDResource NameUnitsCostBaseline CostAct. CostRem. CostWorkOvt. WorkBaseline WorkAct. WorkRem. Work						
	8ElecTechU10%\$0\$0\$0\$032 h0 h0 h0 h32 h						
	15MandS4,706.56\$4,707\$0\$0\$4,7074,706.56004,706.56						

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																																																								
"Fabricate production GAB" continued																																																																															
<div>Notes</div> <div>WBS Definition- Fabricate and assemble production GAB.</div> <div>M&amp;S BOE - Fabricate/Assemble 2 boards = \$3,000, plus 32 hours of university technician \$2133.33/w = \$1706.66 ----- total = \$4,706.66</div> <div>Labor BOE- Based on Fab/Assembly time for STT FRC - 4 weeks. Multiplied by a factor of 2 to account for increased board complexity.</div>																																																																															
1.2.1.4.11	Bench test production GAB	12/16/04	2/7/05	\$0	\$7,984	\$0	\$7,984																																																																								
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>30%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>72 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>72 h</td></tr><tr><td>8</td><td>ElecTechU</td><td>10%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>24 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>24 h</td></tr><tr><td>10</td><td>PhysicistU</td><td>30%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>72 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>72 h</td></tr><tr><td>13</td><td>StudentU</td><td>75%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>180 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>180 h</td></tr><tr><td>15</td><td>MandS</td><td>7,983.84</td><td>\$7,984</td><td>\$0</td><td>\$0</td><td>\$7,984</td><td>7,983.84</td><td></td><td>0</td><td>0</td><td>7,983.84</td></tr></table> <div>Notes</div> <div>WBS Definition- Test full functionality of production boards at Nevis labs with pre-production TABs. Using simulated inputs, verify that all outputs of the board are as expected and that bit error rate in outputs acceptable - corresponding to approximately 1 fatal error per day at the nominal data volume.</div> <div>M&amp;S BOE - 72 h of Columbia electrical engineer at \$3724.40/w = \$6703.92 plus 24 hours of Columbia technician at \$2133.33/w = \$1280.00 ----- total = \$7,983.92</div> <div>Labor BOE- Based on test time for first production STT FRC and BC. Multiplied by a factor of 2 to account for increased system complexity.</div>								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	30%	\$0	\$0	\$0	\$0	72 h	0 h	0 h	0 h	72 h	8	ElecTechU	10%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h	10	PhysicistU	30%	\$0	\$0	\$0	\$0	72 h	0 h	0 h	0 h	72 h	13	StudentU	75%	\$0	\$0	\$0	\$0	180 h	0 h	0 h	0 h	180 h	15	MandS	7,983.84	\$7,984	\$0	\$0	\$7,984	7,983.84		0	0	7,983.84
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																																				
4	ElecEngU	30%	\$0	\$0	\$0	\$0	72 h	0 h	0 h	0 h	72 h																																																																				
8	ElecTechU	10%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h																																																																				
10	PhysicistU	30%	\$0	\$0	\$0	\$0	72 h	0 h	0 h	0 h	72 h																																																																				
13	StudentU	75%	\$0	\$0	\$0	\$0	180 h	0 h	0 h	0 h	180 h																																																																				
15	MandS	7,983.84	\$7,984	\$0	\$0	\$7,984	7,983.84		0	0	7,983.84																																																																				
1.2.1.5	Cables	9/9/02	11/1/04	\$20,781	\$4,050	\$0	\$24,831																																																																								
<div>Notes</div> <div>WBS Definition- Cal trigger cables</div>																																																																															
1.2.1.5.1	Design and Fabricate system to test ADF to TAB cable	9/9/02	10/18/02	\$3,000	\$427	\$0	\$3,427																																																																								
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>8</td><td>ElecTechU</td><td>3%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>8 h</td><td>0 h</td><td>0 h</td><td>7.2 h</td><td>0.8 h</td></tr><tr><td>15</td><td>MandS</td><td>3,426.64</td><td>\$3,427</td><td>\$0</td><td>\$3,427</td><td>\$0</td><td>3,426.64</td><td></td><td>0</td><td>3,083.98</td><td>342.66</td></tr></table> <div>Notes</div> <div>WBS Definition- Fabricate test cards (receiver and transmitter) plus sample cables to test cable and Channel Link chip characteristics using HP signal generator.</div> <div>M&amp;S BOE- Cost based on similar test systems made at Nevis for cable tests. Equipment = \$3000 plus 8 hours of Columbia technician at \$2133.33/w = \$427.00 ----- total = \$3,427.00</div> <div>Labor BOE- Duration based on average amount of time for similar test systems made at Nevis.</div>								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	8	ElecTechU	3%	\$0	\$0	\$0	\$0	8 h	0 h	0 h	7.2 h	0.8 h	15	MandS	3,426.64	\$3,427	\$0	\$3,427	\$0	3,426.64		0	3,083.98	342.66																																				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																																				
8	ElecTechU	3%	\$0	\$0	\$0	\$0	8 h	0 h	0 h	7.2 h	0.8 h																																																																				
15	MandS	3,426.64	\$3,427	\$0	\$3,427	\$0	3,426.64		0	3,083.98	342.66																																																																				



WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																																	
1.2.1.5.2	Test ADF to TAB cables	10/21/02	11/1/02	\$0	\$1,490	\$0	\$1,490																																																	
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>20%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>16 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>16 h</td></tr><tr><td>13</td><td>StudentU</td><td>50%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>40 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>40 h</td></tr><tr><td>15</td><td>MandS</td><td>1,489.76</td><td>\$1,490</td><td>\$0</td><td>\$0</td><td>\$1,490</td><td>1,489.76</td><td></td><td>0</td><td>0</td><td>1,489.76</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	20%	\$0	\$0	\$0	\$0	16 h	0 h	0 h	0 h	16 h	13	StudentU	50%	\$0	\$0	\$0	\$0	40 h	0 h	0 h	0 h	40 h	15	MandS	1,489.76	\$1,490	\$0	\$0	\$1,490	1,489.76		0	0	1,489.76							
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																													
4	ElecEngU	20%	\$0	\$0	\$0	\$0	16 h	0 h	0 h	0 h	16 h																																													
13	StudentU	50%	\$0	\$0	\$0	\$0	40 h	0 h	0 h	0 h	40 h																																													
15	MandS	1,489.76	\$1,490	\$0	\$0	\$1,490	1,489.76		0	0	1,489.76																																													
	<u>Notes</u>																																																							
	WBS Definition- Test ADF to TAB cable properties using signal generator at Nevis. Cables must exhibit acceptable signal degradation (no bit-errors) when run at the rate foreseen in the L1Cal (384 MHz).																																																							
	M&S BOE - 16 hours of Columbia engineer at \$3724.40/w = \$1,489.76																																																							
	Labor BOE- Based on the amount of effort required for similar cable tests at Nevis.																																																							

1.2.1.5.3	Procure ADF to TAB cables	8/23/04	11/1/04	\$17,781	\$2,133	\$0	\$19,914																																					
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>8</td><td>ElecTechU</td><td>10%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>40 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>40 h</td></tr><tr><td>15</td><td>MandS</td><td>19,914.1</td><td>\$19,914</td><td>\$0</td><td>\$0</td><td>\$19,914</td><td>19,914.1</td><td></td><td>0</td><td>0</td><td>19,914.1</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	8	ElecTechU	10%	\$0	\$0	\$0	\$0	40 h	0 h	0 h	0 h	40 h	15	MandS	19,914.1	\$19,914	\$0	\$0	\$19,914	19,914.1		0	0	19,914.1							
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																	
8	ElecTechU	10%	\$0	\$0	\$0	\$0	40 h	0 h	0 h	0 h	40 h																																	
15	MandS	19,914.1	\$19,914	\$0	\$0	\$19,914	19,914.1		0	0	19,914.1																																	
	<u>Notes</u>																																											
	WBS Definition- Purchase all cables + spares required for the L1 Cal system.																																											
	M&S BOE- Cable cost estimate taken from quote from Tyco electronics. 240 cables + 30 spares are required at 250*\$62.76/cable + 20*105.67 = \$17,780.90 plus 40 hours of Columbia technician at \$2133.33/w = \$2,133.33 ----- total = \$19,914.23																																											
	Labor BOE- Duration based on average amount of time for cable procurement. Labor based on average effort for purchases at Fermilab.																																											

1.2.1.6	TAB Crates and Services	8/23/02	12/15/04	\$23,700	\$11,729	\$0	\$35,429
	<u>Notes</u>						
	WBS Definition-						

1.2.1.6.1	Procure TAB crate for prototype TAB/GAB	8/23/02	12/17/02	\$8,100	\$3,413	\$0	\$11,513																																					
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>8</td><td>ElecTechU</td><td>10%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>64 h</td><td>0 h</td><td>0 h</td><td>12.8 h</td><td>51.2 h</td></tr><tr><td>15</td><td>MandS</td><td>11,513.12</td><td>\$11,513</td><td>\$0</td><td>\$11,513</td><td>\$0</td><td>11,513.12</td><td></td><td>0</td><td>2,302.62</td><td>9,210.5</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	8	ElecTechU	10%	\$0	\$0	\$0	\$0	64 h	0 h	0 h	12.8 h	51.2 h	15	MandS	11,513.12	\$11,513	\$0	\$11,513	\$0	11,513.12		0	2,302.62	9,210.5							
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																	
8	ElecTechU	10%	\$0	\$0	\$0	\$0	64 h	0 h	0 h	12.8 h	51.2 h																																	
15	MandS	11,513.12	\$11,513	\$0	\$11,513	\$0	11,513.12		0	2,302.62	9,210.5																																	
	<u>Notes</u>																																											
	WBS Definition- Procure one 9U VME crate + VIPA backplane for use in testing prototype TABs and GABs at Nevis.																																											
	M&S BOE- Cost (\$8,100) based on similar crate+backplane purchased for STT system. Crate (sub-rack) cost was \$4690 while VIPA backplane was \$3375. Power supply will be taken from Nevis labs stock. Equipment = \$8100 plus 64 hours of Columbia technician at \$2133.33/w = \$3413.33 ----- total = \$11,513.33																																											
	Labor BOE- Duration based on amount of time required to purchase similar crates for the STT project. Labor based on average effort for purchases at Fermilab.																																											

1.2.1.6.2	Procure VME CPU for prototype TAB/GAB	10/7/02	12/3/02	\$3,250	\$1,707	\$0	\$4,957																																					
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>8</td><td>ElecTechU</td><td>10%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>32 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>32 h</td></tr><tr><td>15</td><td>MandS</td><td>4,956.56</td><td>\$4,957</td><td>\$0</td><td>\$0</td><td>\$4,957</td><td>4,956.56</td><td></td><td>0</td><td>0</td><td>4,956.56</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	8	ElecTechU	10%	\$0	\$0	\$0	\$0	32 h	0 h	0 h	0 h	32 h	15	MandS	4,956.56	\$4,957	\$0	\$0	\$4,957	4,956.56		0	0	4,956.56							
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																	
8	ElecTechU	10%	\$0	\$0	\$0	\$0	32 h	0 h	0 h	0 h	32 h																																	
15	MandS	4,956.56	\$4,957	\$0	\$0	\$4,957	4,956.56		0	0	4,956.56																																	

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost					
"Procure VME CPU for prototype TAB/GAB" continued												
<u>Notes</u> WBS Definition- Procure one VME CPU for use in testing prototype TABs and GABs at Nevis.  M&S BOE- Cost based on similar CPU purchased for STT system. Equipment = \$3250 plus 32 hours of university technician at \$2133.33/w = \$1706.66 ----- total = \$4,956.66  Labor BOE- Duration based on amount of time required to purchase CPUs for the STT project. Labor based on average effort for purchases at Fermilab.												
1.2.1.6.3	Specify TAB crate/power/cooling	4/20/04	5/3/04	\$0	\$1,490	\$0	\$1,490					
	<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
	4	ElecEngU	20%	\$0	\$0	\$0	\$0	16 h	0 h	0 h	0 h	16 h
	15	MandS	1,489.76	\$1,490	\$0	\$0	\$1,490	1,489.76		0	0	1,489.76
<u>Notes</u> WBS Definition- Produce final specification for power, cooling and related services for TAB/GAB crate to be used at Fermilab.  M&S BOE- Time estimate takes into account two iterations with Fermilab engineers on these spec's. Cost is based on 16 hours of university engineer at \$3891.30/w = \$1,556.52												
1.2.1.6.4	Procure TAB crate	8/23/04	12/15/04	\$9,100	\$3,413	\$0	\$12,513					
	<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
	8	ElecTechU	10%	\$0	\$0	\$0	\$0	64 h	0 h	0 h	0 h	64 h
	15	MandS	12,513.12	\$12,513	\$0	\$0	\$12,513	12,513.12		0	0	12,513.12
<u>Notes</u> WBS Definition- Procure one 9U VME crate + VIPA backplane for use in final system at Fermilab.  M&S BOE- Cost based on similar crate+backplane purchased for STT system. Crate (sub-rack) cost was \$4690 while VIPA backplane was \$3410. Power supply and cooling estimated to cost \$1000 based on similar components in L1muon system. Equipment = \$9100 plus 64 hours of electrical tech at \$2133.33/w = \$3413.33 ----- total = 12,513.33  Labor BOE- Duration based on amount of time required to purchase similar crates for the STT project. Labor based on average effort for purchases at Fermilab.												
1.2.1.6.5	Procure TAB VME CPU	8/23/04	10/18/04	\$3,250	\$1,707	\$0	\$4,957					
	<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
	8	ElecTechU	10%	\$0	\$0	\$0	\$0	32 h	0 h	0 h	0 h	32 h
	15	MandS	4,956.56	\$4,957	\$0	\$0	\$4,957	4,956.56		0	0	4,956.56
<u>Notes</u> WBS Definition- Procure one VME CPU for use in TAB/GAB crate at Fermilab.  M&S BOE- Cost based on similar CPU purchased for STT system (\$3250) Equipment = \$3250 plus 32 hour of university technical at \$2133.33/w = \$1706.66 ----- total = \$4,956.66												

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																																																	
"Procure TAB VME CPU" continued																																																																								
	<u>Notes</u> Labor BOE- Duration based on amount of time required to purchase CPUs for the STT project. Labor based on average effort for purchases at Fermilab.																																																																							
1.2.1.7	L1 Calorimeter Trigger TAB/GAB Prototyping Com	7/16/03	7/16/03	\$0	\$0	\$0	\$0																																																																	
	<u>Notes</u> WBS Definition- Milestone. Achieved when 8 production TABs and 1 production GAB pass all benchmark tests.																																																																							
1.2.1.8	L1 Calorimeter Trigger TAB/GAB Production and T	2/7/05	2/7/05	\$0	\$0	\$0	\$0																																																																	
	<u>Notes</u> WBS Definition- Milestone. Achieved when 8 production TABs and 1 production GAB pass all benchmark tests.																																																																							
1.2.1.9	Prototype Integration	12/4/02	10/9/03	\$0	\$44,949	\$2,496	\$47,445																																																																	
	<u>Notes</u> WBS Definition- This summary task describes the first stage of a series of tests which combine different boards and eventually the DZero trigger framework (TFW) to ensure that they all work together properly.  Risk Mitigation (schedule)- The impact of integration taking longer than expected is reduced by putting this task as early in the project as possible. Additionally, prototype integration tests are planned to mimic as closely as possible data taking in the D0 environment, including the use of real data from the BLS (via splitter cards) and real timing signals from the Trigger Framework.																																																																							
1.2.1.9.1	Develop in-situ exercising/debugging software	12/4/02	5/2/03	\$0	\$16,494	\$0	\$16,494																																																																	
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>50%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>400 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>400 h</td></tr><tr><td>10</td><td>PhysicistU</td><td>50%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>400 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>400 h</td></tr><tr><td>15</td><td>MandS</td><td>16,494.4</td><td>\$16,494</td><td>\$0</td><td>\$0</td><td>\$16,494</td><td>16,494.4</td><td></td><td>0</td><td>0</td><td>16,494.4</td></tr></table> <u>Notes</u> WBS Definition- Develop special in situ test and diagnostic software that cycles the system at design speed and verifies that the hardware gets the right answer.  M&S BOE- 400 hours of university engineer at \$4123.49/w = \$41,234.93  Labor BOE- Based on similar software development for existing L1Cal.	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	50%	\$0	\$0	\$0	\$0	400 h	0 h	0 h	0 h	400 h	10	PhysicistU	50%	\$0	\$0	\$0	\$0	400 h	0 h	0 h	0 h	400 h	15	MandS	16,494.4	\$16,494	\$0	\$0	\$16,494	16,494.4		0	0	16,494.4																							
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																													
4	ElecEngU	50%	\$0	\$0	\$0	\$0	400 h	0 h	0 h	0 h	400 h																																																													
10	PhysicistU	50%	\$0	\$0	\$0	\$0	400 h	0 h	0 h	0 h	400 h																																																													
15	MandS	16,494.4	\$16,494	\$0	\$0	\$16,494	16,494.4		0	0	16,494.4																																																													
1.2.1.9.2	Prototype integration test ADF+TAB:Columbia	7/17/03	8/13/03	\$0	\$2,980	\$0	\$2,980																																																																	
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>20%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>32 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>32 h</td></tr><tr><td>10</td><td>PhysicistU</td><td>10%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>16 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>16 h</td></tr><tr><td>13</td><td>StudentU</td><td>50%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>80 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>80 h</td></tr><tr><td>15</td><td>MandS</td><td>2,979.52</td><td>\$2,980</td><td>\$0</td><td>\$0</td><td>\$2,980</td><td>2,979.52</td><td></td><td>0</td><td>0</td><td>2,979.52</td></tr></table> <u>Notes</u> Definition- Test prototype TAB with signals from prototype ADF. Test is complete when signals from all 32 channels from two or more ADFs are received at a TAB with no data corruption. This item represents the Columbia part of the effort.  M&S BOE - 32 hours Columbia engineer at \$3724.40/w = \$2,979.52  Labor BOE- Based on the amount of effort required to STT FRC to the STT STC and TFC. These transmissions also involved LVDS technology. An extra 2 weeks is assigned above the STT time because of the higher transmission frequency in the L1 Cal system.	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	20%	\$0	\$0	\$0	\$0	32 h	0 h	0 h	0 h	32 h	10	PhysicistU	10%	\$0	\$0	\$0	\$0	16 h	0 h	0 h	0 h	16 h	13	StudentU	50%	\$0	\$0	\$0	\$0	80 h	0 h	0 h	0 h	80 h	15	MandS	2,979.52	\$2,980	\$0	\$0	\$2,980	2,979.52		0	0	2,979.52											
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																													
4	ElecEngU	20%	\$0	\$0	\$0	\$0	32 h	0 h	0 h	0 h	32 h																																																													
10	PhysicistU	10%	\$0	\$0	\$0	\$0	16 h	0 h	0 h	0 h	16 h																																																													
13	StudentU	50%	\$0	\$0	\$0	\$0	80 h	0 h	0 h	0 h	80 h																																																													
15	MandS	2,979.52	\$2,980	\$0	\$0	\$2,980	2,979.52		0	0	2,979.52																																																													

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.1.9.3	Prototype integration test ADF+TAB:Saclay	7/17/03	8/13/03	\$0	\$3,299	\$0	\$3,299
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 20% \$0 \$0 \$0 \$0 32 h 0 h 0 h 0 h 32 h						
	10 PhysicistU 10% \$0 \$0 \$0 \$0 16 h 0 h 0 h 0 h 16 h						
	13 StudentU 50% \$0 \$0 \$0 \$0 80 h 0 h 0 h 0 h 80 h						
	15 MandS 3,298.88 \$3,299 \$0 \$0 \$3,299 3,298.88 0 0 3,298.88						
	<u>Notes</u>						
	WBS Definition- Same as above, but for Saclay effort required.						
	M&S BOE - 32 hours Saclay engineer at \$4122.95/w = \$3,298.36						
	Labor BOE- Same as above.						
1.2.1.9.4	Prototype integration test ADF+TAB+GAB+TFW: MSL	8/14/03	10/9/03	\$0	\$9,620	\$2,496	\$12,116
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 29% \$0 \$0 \$0 \$0 93 h 0 h 0 h 0 h 93 h						
	7 ElecTechF 20% \$2,496 \$0 \$0 \$2,496 64 h 0 h 0 h 0 h 64 h						
	10 PhysicistU 30% \$0 \$0 \$0 \$0 96 h 0 h 0 h 0 h 96 h						
	15 MandS 9,619.84 \$9,620 \$0 \$0 \$9,620 9,619.84 0 0 9,619.84						
	<u>Notes</u>						
	WBS Definition- Test all prototype elements of L1Cal with timing signals sent from the TFW. Multiple test data events should be sent through the ADF-TAB-GAB chain using timing derived from the SCL. GAB output should be as expected for ADF test input and should be correctly received at the TFW. This item represents the MSU part of the effort.						
	M&S BOE- 93 h of MSU engineer at \$4123.49/w = \$9,587.11						
	Labor BOE- Based on the amount of interaction with TFW experts during the STT integration. This effort has been scaled up by approximately a factor of 4 to take into account the more complicated interface between the L1Cal and TFW. 64 h of fermilab technician is used for this task.						
1.2.1.9.5	Prototype integration test ADF+TAB+GAB+TFW: Colu	8/14/03	10/9/03	\$0	\$5,959	\$0	\$5,959
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 20% \$0 \$0 \$0 \$0 64 h 0 h 0 h 0 h 64 h						
	10 PhysicistU 10% \$0 \$0 \$0 \$0 32 h 0 h 0 h 0 h 32 h						
	13 StudentU 50% \$0 \$0 \$0 \$0 160 h 0 h 0 h 0 h 160 h						
	15 MandS 5,959.04 \$5,959 \$0 \$0 \$5,959 5,959.04 0 0 5,959.04						
	<u>Notes</u>						
	WBS Definition- Same as above, but for Columbia effort required.						
	M&S BOE - 64 h of Columbia engineer at \$3724.40/w = \$5,959.04						
	Labor BOE- Based on experience integrating the STT FRC and TFC. Three periods of integration work of 1 week at Fermilab are assumed separated by 2-week intervals for modifications to the boards/firmware at Nevis and Saclay. Contingency is assigned to take into account the possible need for an extra round of changes to the boards at the universities.						
1.2.1.9.6	Prototype integration test ADF+TAB+GAB+TFW: Sacl	8/14/03	10/9/03	\$0	\$6,598	\$0	\$6,598
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 20% \$0 \$0 \$0 \$0 64 h 0 h 0 h 0 h 64 h						
	10 PhysicistU 10% \$0 \$0 \$0 \$0 32 h 0 h 0 h 0 h 32 h						
	13 StudentU 50% \$0 \$0 \$0 \$0 160 h 0 h 0 h 0 h 160 h						
	15 MandS 6,597.76 \$6,598 \$0 \$0 \$6,598 6,597.76 0 0 6,597.76						
	<u>Notes</u>						
	WBS Definition- Same as above, but for Saclay effort required.						

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost					
"Prototype integration test ADF+TAB+GAB+TFW: Saclay" continued												
	<u>Notes</u>											
	M&S BOE - 64 h of Saclay engineer at \$4122.95/w = \$6,596.72											
	Labor BOE- Same as above.											
1.2.1.10	Pre-Production Integration	4/8/04	5/12/04	\$0	\$12,857	\$4,184	\$17,041					
	<u>Notes</u>											
	WBS Definition- This summary task describes the second stage of a series of tests which combine different boards and eventually the DZero trigger framework (TFW) to ensure that they all work together properly.											
	Risk Mitigation (schedule)- Impact on the schedule of mis-estimates of the time required to complete this task is minimized by performing as much of the integration as possible with prototype boards (1.2.1.9).											
1.2.1.10.1	Pre-production integration test ADF+TAB+TFW: MSU	4/8/04	5/5/04	\$0	\$4,259	\$2,496	\$6,755					
	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
	4	ElecEngU	26%	\$0	\$0	\$0	\$0	41 h	0 h	0 h	0 h	41 h
	7	ElecTechF	40%	\$2,496	\$0	\$0	\$2,496	64 h	0 h	0 h	0 h	64 h
	10	PhysicistU	30%	\$0	\$0	\$0	\$0	48 h	0 h	0 h	0 h	48 h
	15	MandS	4,258.88	\$4,259	\$0	\$0	\$4,259	4,258.88		0	0	4,258.88
	<u>Notes</u>											
	WBS Definition- Same as for 1.2.1.9.2, but for first round of production boards.											
	M&S BOE - 41 h of MSU engineer at \$4123.49/w = \$4,226.58											
	Labor BOE- Estimated to be half of the prototype integration time. 32 h of fermilab technician included.											
1.2.1.10.2	Pre-production integration test ADF+TAB+TFW: Colun	4/8/04	5/5/04	\$0	\$3,940	\$1,248	\$5,188					
	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
	4	ElecEngU	26%	\$0	\$0	\$0	\$0	42 h	0 h	0 h	0 h	42 h
	7	ElecTechF	20%	\$1,248	\$0	\$0	\$1,248	32 h	0 h	0 h	0 h	32 h
	10	PhysicistU	30%	\$0	\$0	\$0	\$0	48 h	0 h	0 h	0 h	48 h
	15	MandS	3,939.52	\$3,940	\$0	\$0	\$3,940	3,939.52		0	0	3,939.52
	<u>Notes</u>											
	WBS Definition- Same as above, but for Columbia effort											
	M&S BOE - 42 h of Columbia engineer at \$3724.40/w = \$3,910.62											
	Labor BOE- Estimated to be half of the prototype integration time. Contingency is assigned to take into account the possible need for an extra round of changes to the boards at the universities. 32 h of fermilab technician included.											
1.2.1.10.3	Pre-production integration test ADF+TAB+TFW: Sacla	4/8/04	5/5/04	\$0	\$4,259	\$0	\$4,259					
	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
	4	ElecEngU	26%	\$0	\$0	\$0	\$0	41 h	0 h	0 h	0 h	41 h
	10	PhysicistU	30%	\$0	\$0	\$0	\$0	48 h	0 h	0 h	0 h	48 h
	15	MandS	4,258.88	\$4,259	\$0	\$0	\$4,259	4,258.88		0	0	4,258.88
	<u>Notes</u>											
	WBS Definition- Same as above, but for Saclay effort											
	M&S BOE-											

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																																												
"Pre-production integration test ADF+TAB+TFW: Saclay" continued																																																																			
<u>Notes</u> 41 h of Saclay engineer at \$4122.95/w = \$4,226.02  Labor BOE- Same as above.																																																																			
1.2.1.10.4	Production readiness review	5/6/04	5/12/04	\$0	\$400	\$440	\$840																																																												
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>3</td><td>ElecEngF</td><td>20%</td><td>\$440</td><td>\$0</td><td>\$0</td><td>\$440</td><td>8 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>8 h</td></tr><tr><td>4</td><td>ElecEngU</td><td>10%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>4 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>4 h</td></tr><tr><td>10</td><td>PhysicistU</td><td>100%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>40 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>40 h</td></tr><tr><td>15</td><td>MandS</td><td>400</td><td>\$400</td><td>\$0</td><td>\$0</td><td>\$400</td><td>400</td><td></td><td>0</td><td>0</td><td>400</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	3	ElecEngF	20%	\$440	\$0	\$0	\$440	8 h	0 h	0 h	0 h	8 h	4	ElecEngU	10%	\$0	\$0	\$0	\$0	4 h	0 h	0 h	0 h	4 h	10	PhysicistU	100%	\$0	\$0	\$0	\$0	40 h	0 h	0 h	0 h	40 h	15	MandS	400	\$400	\$0	\$0	\$400	400		0	0	400						
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																								
3	ElecEngF	20%	\$440	\$0	\$0	\$440	8 h	0 h	0 h	0 h	8 h																																																								
4	ElecEngU	10%	\$0	\$0	\$0	\$0	4 h	0 h	0 h	0 h	4 h																																																								
10	PhysicistU	100%	\$0	\$0	\$0	\$0	40 h	0 h	0 h	0 h	40 h																																																								
15	MandS	400	\$400	\$0	\$0	\$400	400		0	0	400																																																								
<u>Notes</u> WBS Definition- Review to determine readiness of L1Cal system to go into production.  M&S BOE- 4 h of university engineer at \$100/h = \$400  Labor BOE- 8 h of fermilab engineer included.																																																																			
1.2.1.11	L1 Cal Online Software	1/6/03	1/10/05	\$0	\$0	\$0	\$0																																																												
<u>Notes</u> WBS Definition- Develop software for controls, downloading, online diagnostics of L1 Cal system. This includes downloading information from the hardware database, setting up monitoring via the EPICs system, establishing a secondary data acquisition system for recording events without the level 3 system.																																																																			
1.2.1.11.1	ADF online software	1/6/03	1/10/05	\$0	\$0	\$0	\$0																																																												
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>10</td><td>PhysicistU</td><td>10%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>400 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>400 h</td></tr><tr><td>14</td><td>PostdocU</td><td>25%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>1,000 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>1,000 h</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	10	PhysicistU	10%	\$0	\$0	\$0	\$0	400 h	0 h	0 h	0 h	400 h	14	PostdocU	25%	\$0	\$0	\$0	\$0	1,000 h	0 h	0 h	0 h	1,000 h																														
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																								
10	PhysicistU	10%	\$0	\$0	\$0	\$0	400 h	0 h	0 h	0 h	400 h																																																								
14	PostdocU	25%	\$0	\$0	\$0	\$0	1,000 h	0 h	0 h	0 h	1,000 h																																																								
<u>Notes</u> WBS Definition - Write/modify the particular code and data structures that are necessary to operate and monitor the ADF system in the Dzero online environment. This includes downloading information from the hardware database, setting up monitoring via the EPICs system, establishing a secondary data acquisition system for recording events without the level 3 system.  Labor BOE- Based on similar tasks for the run2a muon system, which required 50% of a post doc plus 10% of a professor for two years. Since much of the infrastructure is already in place, and similar efforts with the TAB system can be done in conjunction, only 25% of a postdoc is expected to be requires, assuming that another 25% of the same person is spent on TAB online software.																																																																			
1.2.1.11.2	TAB/GAB online software	1/6/03	1/10/05	\$0	\$0	\$0	\$0																																																												
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>10</td><td>PhysicistU</td><td>10%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>400 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>400 h</td></tr><tr><td>14</td><td>PostdocU</td><td>25%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>1,000 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>1,000 h</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	10	PhysicistU	10%	\$0	\$0	\$0	\$0	400 h	0 h	0 h	0 h	400 h	14	PostdocU	25%	\$0	\$0	\$0	\$0	1,000 h	0 h	0 h	0 h	1,000 h																														
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																								
10	PhysicistU	10%	\$0	\$0	\$0	\$0	400 h	0 h	0 h	0 h	400 h																																																								
14	PostdocU	25%	\$0	\$0	\$0	\$0	1,000 h	0 h	0 h	0 h	1,000 h																																																								
<u>Notes</u> WBS Definition- Write/modify the particular code and data structures that are necessary to operate and monitor the TAB/GAB system in the Dzero online environment. This includes downloading information from the hardware database, setting up monitoring via the EPICs system, establishing a secondary data acquisition system for recording events without the level 3 system.  Labor BOE- Based on similar tasks for the run2a muon system, which required 50% of a post doc plus 10% of a professor for two years. Since much of the infrastructure is already in place, and similar efforts with the ADF system can be done in conjunction, only 25% of a postdoc is expected to be requires, assuming that another 25% of the same person is spent on ADF online software.																																																																			
1.2.1.12	L1 Calorimeter Trigger Production And Testing Co	2/7/05	2/7/05	\$0	\$0	\$0	\$0																																																												
<u>Notes</u> WBS Definition- Milestone: All L1 Cal components produced or procured. Full functionality of custom boards (ADF, TAB, GAB) bench tested at institutes where they were developed. Tests consist of using simulated inputs to																																																																			

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																																												
<b>"L1 Calorimeter Trigger Production And Testing Complete" continued</b>																																																																			
<u>Notes</u> verify that all the outputs of the board are as expected and that bit error rates are acceptable - corresponding to approximately 1 fatal error per day at nominal data volumes. Milestone is achieved when the number of boards required in the system (80 ADFs, 8 TABs and 1 GAB) have passed the bench tests above.																																																																			
1.2.2	Level 1 Calorimeter Track Matching	8/1/02	7/14/04	\$177,504	\$40,560	\$30,080	\$248,144																																																												
<u>Notes</u> WBS Definition- This summary element provides for improvements in the Run2a track-matching trigger. It includes development and procurement of slightly modified versions of existing Level 1 muon cards, and procurement of related cabling, connectors, readout crates, processors, and power supplies.																																																																			
1.2.2.1	D0 Reviews	1/23/03	6/2/03	\$0	\$400	\$440	\$840																																																												
<u>Notes</u> WBS Definition- milestone: a review by D0 electronics experts (inside and outside of the project) ensures that the design is sound and meets all of the specifications for operation in the D0 trigger and data acquisition systems.																																																																			
1.2.2.1.1	D0 Internal Design Review Complete	1/23/03	1/23/03	\$0	\$0	\$0	\$0																																																												
<u>Notes</u> WBS Definition D0 internal design review with Fermilab, L1CTT, and L1Cal engineers																																																																			
1.2.2.1.2	D0 Production Readiness Review	5/27/03	6/2/03	\$0	\$400	\$440	\$840																																																												
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>3</td><td>ElecEngF</td><td>20%</td><td>\$440</td><td>\$0</td><td>\$0</td><td>\$440</td><td>8 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>8 h</td></tr><tr><td>4</td><td>ElecEngU</td><td>10%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>4 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>4 h</td></tr><tr><td>10</td><td>PhysicistU</td><td>50%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>20 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>20 h</td></tr><tr><td>15</td><td>MandS</td><td>400</td><td>\$400</td><td>\$0</td><td>\$0</td><td>\$400</td><td>400</td><td></td><td>0</td><td>0</td><td>400</td></tr></table>								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	3	ElecEngF	20%	\$440	\$0	\$0	\$440	8 h	0 h	0 h	0 h	8 h	4	ElecEngU	10%	\$0	\$0	\$0	\$0	4 h	0 h	0 h	0 h	4 h	10	PhysicistU	50%	\$0	\$0	\$0	\$0	20 h	0 h	0 h	0 h	20 h	15	MandS	400	\$400	\$0	\$0	\$400	400		0	0	400
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																								
3	ElecEngF	20%	\$440	\$0	\$0	\$440	8 h	0 h	0 h	0 h	8 h																																																								
4	ElecEngU	10%	\$0	\$0	\$0	\$0	4 h	0 h	0 h	0 h	4 h																																																								
10	PhysicistU	50%	\$0	\$0	\$0	\$0	20 h	0 h	0 h	0 h	20 h																																																								
15	MandS	400	\$400	\$0	\$0	\$400	400		0	0	400																																																								
<u>Notes</u> WBS Definition D0 production readiness review before start of MTCxx, MTCM, and MTFB production  M&S BOE- 4 h of university engineer at \$100/h = \$400  Labor BOE- 8 h of fermilab engineer included.																																																																			
1.2.2.2	L1 Trigger Cal-Trk Match R&D MOU (UAZ) Complete	11/1/02	11/1/02	\$0	\$0	\$0	\$0																																																												
<u>Notes</u> WBS Definition- milestone: R&D MOU with University of Arizona is signed																																																																			
1.2.2.3	L1 Trigger Cal-Trk Match Equipment MOU (UAZ) Complete	12/2/02	12/2/02	\$0	\$0	\$0	\$0																																																												
<u>Notes</u> WBS Definition- milestone: Equipment MOU with University of Arizona is signed.																																																																			
1.2.2.4	SLDB	12/2/02	9/8/03	\$39,874	\$3,869	\$0	\$43,743																																																												
<u>Notes</u> WBS Definition- This summary task covers the fabrication of the Serial Link Daughter Boards that are needed to transmit and receive signals between the L1CTT, L1Cal, and the L1 Cal-Trk Trigger																																																																			
1.2.2.4.1	Procure SLDB parts	12/2/02	2/5/03	\$28,771	\$383	\$0	\$29,153																																																												
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>10%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>32 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>32 h</td></tr><tr><td>15</td><td>MandS</td><td>29,153.22</td><td>\$29,153</td><td>\$0</td><td>\$0</td><td>\$29,153</td><td>29,153.22</td><td></td><td>0</td><td>0</td><td>29,153.22</td></tr></table>								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	10%	\$0	\$0	\$0	\$0	32 h	0 h	0 h	0 h	32 h	15	MandS	29,153.22	\$29,153	\$0	\$0	\$29,153	29,153.22		0	0	29,153.22																								
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																								
4	ElecEngU	10%	\$0	\$0	\$0	\$0	32 h	0 h	0 h	0 h	32 h																																																								
15	MandS	29,153.22	\$29,153	\$0	\$0	\$29,153	29,153.22		0	0	29,153.22																																																								
<u>Notes</u> WBS Definition																																																																			

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Procure SLDB parts" continued							
	<u>Notes</u> Procure the parts needed for all of the serial link daughter boards  M&S Labor BOE Same engineer as in run2a will be responsible for procurement and has all records of prices and vendors M&S labor = 32 hours of EEU = \$382.72 M&S labor pays 20% of EEU salary + ere + overhead, university 80%  M&S Equipment BOE 17*8+1=137 transmitter boards @ \$103.4 = \$14165.8 17*11 = 187 receiver boards @ \$78.1 = \$14604.7 total \$28770.50  unit costs based on actual costs of SLDB parts in run2a * 1.1 (see BOE binder for detailed breakdown).  M&S total = \$29153.22						

1.2.2.4.2

Fabricate and assemble SLDBs

2/6/03

7/11/03

\$11,103

\$316

\$0

\$11,419

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngU	3%	\$0	\$0	\$0	\$0	26.4 h	0 h	0 h	0 h	26.4 h
15	MandS	11,419.14	\$11,419	\$0	\$0	\$11,419	11,419.14		0	0	11,419.14

Notes

WBS Definition

fabricate and assemble the serial link daughter boards that are needed for the cal-track matching system

M&S Labor BOE

Same engineer as in run2a will be responsible for tracking the fabrication and assembly.

M&S labor = 26.4h of an EEU = \$315.74

M&S labor pays only 20% of EEU salary + ere + overhead, university 80%

M&S Equipment BOE-

137 transmitter boards @ \$33 = \$4521

187 receiver boards @ \$35.2 = \$6582.4

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Total \$11103.4

unit costs based on actual costs of SLDB fabrication and assembly in run2a (see BOE binder for PO)

M&S total = \$11419.14

1.2.2.4.3	Test SLDBs	7/14/03		9/8/03		\$0		\$3,170		\$0	\$3,170	
	<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
	4	ElecEngU	20%	\$0	\$0	\$0	\$0	64 h	0 h	0 h	0 h	64 h
	8	ElecTechU	60%	\$0	\$0	\$0	\$0	192 h	0 h	0 h	0 h	192 h
	10	PhysicistU	20%	\$0	\$0	\$0	\$0	64 h	0 h	0 h	0 h	64 h
	15	MandS	3,170.24	\$3,170	\$0	\$0	\$3,170	3,170.24		0	0	3,170.24
	<u>Notes</u>											
	WBS Definition-											
	Test the serial link daughter boards with stand-alone serial link tester.											
	M&S Labor BOE-											
	From run2a, approximately 10 min/board was required for good boards = 55 hours for 324 boards. Additional 200 hours are allowed for debugging and repair of faulty boards.											
	M&S labor = 64h of EEU and 192h of ETU = \$3170.24											
	M&S labor pays 20% of EEU salary + ere + overhead, university 80%											
	M&S labor pays full ETU salary + ere + overhead											



WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost					
"Test SLDBs" continued												
	<u>Notes</u>											
	M&S Equipment BOE- no M&S equipment											
	M&S total = \$3170.24											
1.2.2.5	MTCxx	1/23/03	7/14/04	\$34,587	\$15,994	\$0	\$50,581					
	<u>Notes</u>											
	WBS Definition- This summary task describes the design, fabrication, and testing of the MTCxx cards which receive inputs from the level 1 tracking and calorimeter systems and determine matches.											
1.2.2.5.1	(Small) design changes to MTCxx	1/23/03	4/16/03	\$0	\$2,296	\$0	\$2,296					
	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
	4	ElecEngU	40%	\$0	\$0	\$0	\$0	192 h	0 h	0 h	0 h	192 h
	15	MandS	2,296.32	\$2,296	\$0	\$0	\$2,296	2,296.32		0	0	2,296.32
	<u>Notes</u>											
	WBS Definition- modify existing MTCxx design (which does muon-track matching in run 2a) for the "no MTCM mode" to reduce trigger latency and add 1-2 additional receivers											
	M&S Labor BOE Time estimate based the labor required for the design changes between the prototype and production versions of the Run2a MTCxx. The same engineer will be doing the design changes. M&S labor = 192h of EEU = \$2296.32 M&S labor pays 20% of EEU salary + ere + overhead, university 80%											
	M&S Equipment BOE no M&S associated with this task											
	M&S total = \$2296.32											
1.2.2.5.2	Procure MTCxx parts	3/6/03	5/29/03	\$22,751	\$574	\$0	\$23,325					
	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
	4	ElecEngU	10%	\$0	\$0	\$0	\$0	48 h	0 h	0 h	0 h	48 h
	15	MandS	23,325.38	\$23,325	\$0	\$0	\$23,325	23,325.38		0	0	23,325.38
	<u>Notes</u>											
	WBS Definition- procure the parts to build all MTCxx cards needed by the cal-track matching system, including prototypes and spares.											
	M&S Labor BOE- Same engineer as in run2a will be responsible for procurement and has all records of prices and vendors. M&S labor = 48h of EEU = \$574.08 M&S labor pays 20% of EEU salary + ere + overhead, university 80%											
	M&S Equipment BOE The cost is based on parts cost for the actual Run 2a MTCxx x 1.1. See BOE binder for detailed itemization of costs. 13 cards @ \$1750.1 = \$22751.3											
	M&S total = \$23325.38											
1.2.2.5.3	Fabricate and assemble prototype MTCxx	5/30/03	8/22/03	\$3,718	\$287	\$0	\$4,005					
	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
	4	ElecEngU	5%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h
	15	MandS	4,005.04	\$4,005	\$0	\$0	\$4,005	4,005.04		0	0	4,005.04
	<u>Notes</u>											
	WBS Definition- Fabricate and assemble two prototype MTCxx boards											

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																																													
"Fabricate and assemble prototype MTCxx" continued																																																																				
<div>Notes</div> M&S Labor BOE- Same engineer as in run2a will be responsible for tracking the fabrication and assembly. M&S labor = 24h = \$287.04 M&S labor pays 20% of EEU salary + ere + overhead, university 80%  M&S Equipment BOE- 2 boards @ \$1859 = \$3718  M&S total = \$4005.04  Unit costs based on small-quantity fabrication. See quotes and PO in BOE binder. Fabrication costs are based on an average of 2 quotes																																																																				
1.2.2.5.4	Fabrication and Assembly of L1 Trigger Cal-Trk M	8/22/03	8/22/03	\$0	\$0	\$0	\$0																																																													
<div>Notes</div> WBS Definition- milestone: track prototyping status of MTCxx card																																																																				
1.2.2.5.5	Test prototype MTCxx	8/25/03	10/20/03	\$0	\$4,355	\$0	\$4,355																																																													
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>30%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>96 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>96 h</td></tr><tr><td>8</td><td>ElecTechU</td><td>80%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>256 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>256 h</td></tr><tr><td>10</td><td>PhysicistU</td><td>20%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>64 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>64 h</td></tr><tr><td>15</td><td>MandS</td><td>4,354.56</td><td>\$4,355</td><td>\$0</td><td>\$0</td><td>\$4,355</td><td>4,354.56</td><td></td><td>0</td><td>0</td><td>4,354.56</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	30%	\$0	\$0	\$0	\$0	96 h	0 h	0 h	0 h	96 h	8	ElecTechU	80%	\$0	\$0	\$0	\$0	256 h	0 h	0 h	0 h	256 h	10	PhysicistU	20%	\$0	\$0	\$0	\$0	64 h	0 h	0 h	0 h	64 h	15	MandS	4,354.56	\$4,355	\$0	\$0	\$4,355	4,354.56		0	0	4,354.56							
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																									
4	ElecEngU	30%	\$0	\$0	\$0	\$0	96 h	0 h	0 h	0 h	96 h																																																									
8	ElecTechU	80%	\$0	\$0	\$0	\$0	256 h	0 h	0 h	0 h	256 h																																																									
10	PhysicistU	20%	\$0	\$0	\$0	\$0	64 h	0 h	0 h	0 h	64 h																																																									
15	MandS	4,354.56	\$4,355	\$0	\$0	\$4,355	4,354.56		0	0	4,354.56																																																									
<div>Notes</div> WBS Definition Test functionality of prototype MTCxx card on existing Level-1 muon test stand.  M&S Labor BOE- Based on the time required to test the pre-production MTCxx card in run 2a M&S labor = 96h of EEU and 256h of ETU = \$4354.56 M&S labor pays 20% of EEU salary + ere + overhead, university 80% M&S labor pays full ETU salary + ere + overhead  M&S Equipment BOE- n/a  M&S total = \$4354.56																																																																				
1.2.2.5.6	Final design changes to MTCxx	10/21/03	12/3/03	\$0	\$1,148	\$0	\$1,148																																																													
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>40%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>96 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>96 h</td></tr><tr><td>15</td><td>MandS</td><td>1,148.16</td><td>\$1,148</td><td>\$0</td><td>\$0</td><td>\$1,148</td><td>1,148.16</td><td></td><td>0</td><td>0</td><td>1,148.16</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	40%	\$0	\$0	\$0	\$0	96 h	0 h	0 h	0 h	96 h	15	MandS	1,148.16	\$1,148	\$0	\$0	\$1,148	1,148.16		0	0	1,148.16																															
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																									
4	ElecEngU	40%	\$0	\$0	\$0	\$0	96 h	0 h	0 h	0 h	96 h																																																									
15	MandS	1,148.16	\$1,148	\$0	\$0	\$1,148	1,148.16		0	0	1,148.16																																																									
<div>Notes</div> WBS Definition- Update MTCxx design for problems identified in the prototype testing  M&S Labor BOE- Time estimate based the labor required for the design changes between the prototype and production versions of the Run2a MTCxx, scaled down to one third. The same engineer will be doing the design changes M&S labor = 96h of EEU = \$1148.16 M&S labor pays 20% of EEU salary + ere + overhead, university 80%  M&S Equipment BOE- No M&S equipment associated with this task  M&S total = \$1148.16																																																																				

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.2.5.7	Fabricate and assemble MTCxx's	12/4/03	4/5/04	\$8,118	\$383	\$0	\$8,501

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngU	5%	\$0	\$0	\$0	\$0	32 h	0 h	0 h	0 h	32 h
15	MandS	8,500.72	\$8,501	\$0	\$0	\$8,501	8,500.72	0 h	0	0	8,500.72

Notes

WBS Definition-

Fabricate 11 MTCxx boards, including 2 spares.

M&S Labor BOE-

Same engineer as in run2a will be responsible for tracking the fabrication and assembly.

M&S labor = 32h of EEU = \$382.72

M&S labor pays 20% of EEU salary + ere + overhead, university 80%

M&S Equipment BOE

11 cards @ \$738 = \$8118

Unit costs based on actual costs of MTCxx fabrication and assembly in run2a. See quotes and PO's in BOE binder. Fabrication costs are based on an average of 2 quotes

M&S total = \$8500.72

1.2.2.5.8	Fabrication and Assembly of L1 Trigger Cal-Trk M	4/5/04	4/5/04	\$0	\$0	\$0	\$0
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Notes

WBS Definition-

milestone: to track production status of MTCxx cards

1.2.2.5.9	Test MTCxx's	4/6/04	7/14/04	\$0	\$6,951	\$0	\$6,951
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ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngU	20%	\$0	\$0	\$0	\$0	112 h	0 h	0 h	0 h	112 h
8	ElecTechU	80%	\$0	\$0	\$0	\$0	448 h	0 h	0 h	0 h	448 h
9	PhysicistF	20%	\$0	\$0	\$0	\$0	112 h	0 h	0 h	0 h	112 h
15	MandS	6,950.72	\$6,951	\$0	\$0	\$6,951	6,950.72	0 h	0	0	6,950.72

Notes

WBS Definition-

Test functionality of MTCxx cards on the Level1 muon test stand.

M&S Labor BOE-

Based on Run2a MTCxx rate of 2 days/board (full time) for testing and quick fixes, plus 8 weeks (part time) for fixing more complex problems.

M&S labor = 112h of EEU and 448h of ETU = \$6950.72

M&S labor pays only 20% of EEU salary + ere + overhead, university 80%

M&S labor pays full ETU salary + ere + overhead

M&S Equipment BOE-

There are no M&S equipment costs associated with this task

M&S total = \$6950.72

1.2.2.6	MTCM	3/20/03	1/26/04	\$12,276	\$3,732	\$0	\$16,008
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Notes

WBS Definition-

This summary task describes the design, fabrication and testing of the Muon Trigger Crate Manager. One manager is needed for the crate of MTCxx cards. This card is already used in the run2a muon level 1 muon system.

1.2.2.6.1	(Small) design changes to MTCM	3/20/03	4/30/03	\$0	\$1,148	\$0	\$1,148
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ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngU	30%	\$0	\$0	\$0	\$0	72 h	0 h	0 h	0 h	72 h
15	MandS	1,148.16	\$1,148	\$0	\$0	\$1,148	1,148.16	0 h	0	0	1,148.16

Notes

WBS Definition-

Modify existing MTCM design to fix known minor problems.

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																				
"(Small) design changes to MTCM" continued																																											
<div>Notes</div> <div>M&amp;S Labor BOE- Engineer who designed run2a MTCM will be making modifications. M&amp;S labor = 96h of EEU = \$1148.16 M&amp;S labor pays 20% of EEU salary + ere + overhead, university 80%</div> <div>M&amp;S Equipment BOE- There is no M&amp;Sequipment associated with this task.</div> <div>M&amp;S total = \$1148.16</div>																																											
1.2.2.6.2	Procure MTCM parts	5/1/03	7/25/03	\$8,052	\$574	\$0	\$8,626																																				
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>10%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>48 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>48 h</td></tr><tr><td>15</td><td>MandS</td><td>8,626.08</td><td>\$8,626</td><td>\$0</td><td>\$0</td><td>\$8,626</td><td>8,626.08</td><td>0</td><td>0</td><td>0</td><td>8,626.08</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	10%	\$0	\$0	\$0	\$0	48 h	0 h	0 h	0 h	48 h	15	MandS	8,626.08	\$8,626	\$0	\$0	\$8,626	8,626.08	0	0	0	8,626.08						
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
4	ElecEngU	10%	\$0	\$0	\$0	\$0	48 h	0 h	0 h	0 h	48 h																																
15	MandS	8,626.08	\$8,626	\$0	\$0	\$8,626	8,626.08	0	0	0	8,626.08																																
<div>Notes</div> <div>WBS Definition- Procure the parts to build all MTCM cards needed by the cal-track matching system, including spares.</div> <div>M&amp;S Labor BOE- Same engineer as in run2a will be responsible for procurement and has all records of prices and vendors. M&amp;S labor = 48h of EEU = \$574.08 M&amp;S labor pays 20% of EEU salary + ere + overhead, university 80%</div> <div>M&amp;S Equipment BOE- The cost is based on parts cost for the Run 2a MTCM's x 1.1 3 cards @ \$2684 = \$8052 See BOE binder for detailed itemization of costs.</div> <div>M&amp;S total = \$8626.08</div>																																											
1.2.2.6.3	Fabricate and assemble MTCMs	7/28/03	10/20/03	\$4,224	\$287	\$0	\$4,511																																				
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>5%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>24 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>24 h</td></tr><tr><td>15</td><td>MandS</td><td>4,511.04</td><td>\$4,511</td><td>\$0</td><td>\$0</td><td>\$4,511</td><td>4,511.04</td><td>0</td><td>0</td><td>0</td><td>4,511.04</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	5%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h	15	MandS	4,511.04	\$4,511	\$0	\$0	\$4,511	4,511.04	0	0	0	4,511.04						
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
4	ElecEngU	5%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h																																
15	MandS	4,511.04	\$4,511	\$0	\$0	\$4,511	4,511.04	0	0	0	4,511.04																																
<div>Notes</div> <div>WBS Definition- Fabricate and assmble 3 MTCM cards, including 2 spares.</div> <div>M&amp;S Labor BOE- Same engineer as in run2a will be responsible for tracking the fabrication and assembly. M&amp;S labor = 24h of EEU = \$287.04 M&amp;S labor pays 20% of EEU salary + ere + overhead, university 80%</div> <div>M&amp;S Equipment BOE- 3 cards @ \$1408 = \$4224</div> <div>Unit costs based on actual costs of MTCxx fabrication and assembly in run2a x 1.1. See BOE binder for PO's.</div> <div>M&amp;S total = \$4511.04</div>																																											
1.2.2.6.4	Fabrication and Assembly of L1 Trigger Cal-Trk M:	10/20/03	10/20/03	\$0	\$0	\$0	\$0																																				
<div>Notes</div> <div>WBS Definition milestone:</div>																																											

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.2.6.5	Test MTCMs	10/21/03	1/26/04	\$0	\$1,722	\$0	\$1,722
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 30% \$0 \$0 \$0 \$0 144 h 0 h 0 h 0 h 144 h						
	15 MandS 1,722.24 \$1,722 \$0 \$0 \$1,722 1,722.24 0 0 0 1,722.24						
	<u>Notes</u>						
	WBS Definition- Test functionality of MTCM cards on the existing Level1 muon test stand.						
	M&S Labor BOE- Based on Run2a MTCM testing rate of 1 week/card (cumulative time) M&S labor = 144h of EEU = \$1722.24 M&S labor pays 20% of EEU salary + ere + overhead, university 80%						
	M&S Equipment BOE- No M&S equipment on this task						
	M&S total = \$1722.24						
1.2.2.7	MT Flavor Board	8/1/02	11/3/03	\$20,709	\$11,805	\$0	\$32,514
	<u>Notes</u>						
	WBS Definition- This summary task describes the design, production, and testing of the "muon trigger flavor board" which mounts on the MTCxx and does the actual matching algorithm.						
1.2.2.7.1	Design prototype cal-trk algorithm	8/1/02	12/23/02	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 25% \$0 \$0 \$0 \$0 200 h 0 h 0 h 70 h 130 h						
	<u>Notes</u>						
	WBS definition - Develop and simulate a prototype algorithm to match tracks with calorimeter clusters in the cal-trk match FPGA's						
	Labor BOE - Modification of existing Level 1 muon algorithms with match tracks with muon hits. Time estimate based on run2a experience optimizing existing algorithms						
1.2.2.7.2	Design prototype MTFB	10/17/02	2/19/03	\$0	\$6,304	\$0	\$6,304
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 30% \$0 \$0 \$0 \$0 192 h 0 h 0 h 0 h 192 h						
	8 ElecTechU 50% \$0 \$0 \$0 \$0 320 h 0 h 0 h 0 h 320 h						
	10 PhysicistU 20% \$0 \$0 \$0 \$0 128 h 0 h 0 h 0 h 128 h						
	15 MandS 6,304.32 \$6,304 \$0 \$0 \$6,304 6,304.32 0 0 6,304.32						
	<u>Notes</u>						
	WBS Definition- Modify existing Run2a flavor board design to use more powerful FPGA's and provide serial link output. Work includes schematic, layout, and FPGA program development and simulation						
	M&S Labor BOE- EEU who designed run2a muon trigger flavor board will be doing the design and layout. ETU who worked on run2a muon trigger flavor board FPGA simulations will be doing the FPGA design and simulation. The time is based on the run2a experience of about two months at half time for design and layout. This board contains an additional complication of a serial link which would lengthen the time. However we have also already completed some groundwork on the design of the board itself which would shorten the time. The physicist labor is to help translate the simulation algorithm into an FPGA algorithm.						
	M&S Labor BOE- M&S labor = 192h of EEU and 320h of ETU= \$6304.32 M&S labor pays 20% of EEU salary + ere + overhead, university 80% M&S labor pays full ETU salary + ere + overhead						
	M&S Equipment BOE- No M&S equipment on this task						
	M&S total = \$6304.32						

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.2.7.3	Procure prototype MTFB parts	2/20/03	3/19/03	\$1,540	\$96	\$0	\$1,636
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 5% \$0 \$0 \$0 \$0 8 h 0 h 0 h 0 h 8 h						
	15 MandS 1,635.68 \$1,636 \$0 \$0 \$1,636 1,635.68 0 0 1,635.68						
	<u>Notes</u>						
	WBS Definition-						
	Procure the parts needed for flavor board prototypes						
	M&S Labor BOE-						
	Same engineer as in run2a will be responsible for procurement and has all records of prices and vendors.						
	M&S labor = 8h of EEU = \$95.68						
	M&S labor pays 20% of EEU salary + ere + overhead, university 80%						
	M&S Equipment BOE-						
	See BOE binder for cost based on parts. Cost based on Run2a MTFB boards but with new FPGA; 2 boards @ \$770 = \$1540						
	M&S total = \$1635.68						

1.2.2.7.4	Fabricate and assemble prototype MTFB	3/20/03	5/14/03	\$4,440	\$191	\$0	\$4,631
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 5% \$0 \$0 \$0 \$0 16 h 0 h 0 h 0 h 16 h						
	15 MandS 4,631.36 \$4,631 \$0 \$0 \$4,631 4,631.36 0 0 4,631.36						
	<u>Notes</u>						
	WBS Definition-						
	Fabricate and assemble two prototype MTFB flavor boards						
	M&S Labor BOE-						
	Same engineer as in run2a will be responsible for tracking the fabrication and assembly.						
	M&S labor = 16h of EEU = 191.36\$						
	M&S labor pays 20% of EEU salary + ere + overhead, university 80%						
	M&S Equipment BOE-						
	2 boards at \$2220 = \$4440						
	Unit costs based on actual costs of MTFB assembly * 1.1. Assembly costs were \$72/board plus NRE charges. Fabrication costs are the average of 2 quotes. See BOE binder for run2a po and quotes.						
	M&S total = \$4631.36						

1.2.2.7.5	Fabrication and Assembly of L1 Trigger Cal-Trk M	5/14/03	5/14/03	\$0	\$0	\$0	\$0
	<u>Notes</u>						
	WBS Definition-						
	milestone; to track prototyping status of MTFB						

1.2.2.7.6	Test prototype MTFB	5/15/03	6/12/03	\$0	\$1,986	\$0	\$1,986
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 20% \$0 \$0 \$0 \$0 32 h 0 h 0 h 0 h 32 h						
	8 ElecTechU 80% \$0 \$0 \$0 \$0 128 h 0 h 0 h 0 h 128 h						
	10 PhysicistU 20% \$0 \$0 \$0 \$0 32 h 0 h 0 h 0 h 32 h						
	15 MandS 1,985.92 \$1,986 \$0 \$0 \$1,986 1,985.92 0 0 1,985.92						
	<u>Notes</u>						
	WBS Definition-						
	Test functionality of prototype MTFB on existing Level-1 muon test stand.						
	M&S Labor BOE-						
	Based on the time required to test the production MTFB cards in run 2a of one board per day (full-time) plus additional time for testing new downloading, boundary scan testing, and serial link features.						
	M&S labor = 32h of EEU and 128h of ETU= \$1985.92						
	M&S labor pays 20% of EEU salary + ere + overhead, university 80%						
	M&S labor pays full ETU salary + ere + overhead						
	M&S Equipment BOE						

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost				
"Test prototype MTFB" continued											
<u>Notes</u> There is no M&S equipment associated with this task											
M&S total = \$1985.92											
1.2.2.7.7	Procure MTFB parts	6/13/03	7/11/03	\$8,470	\$153	\$0	\$8,623				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngU	4%	\$0	\$0	\$0	\$0	6.4 h	0 h	0 h	0 h	6.4 h
15	MandS	8,623.09	\$8,623	\$0	\$0	\$8,623	8,623.09		0	0	8,623.09
<u>Notes</u> WBS Definition- Procure the parts to build all MTFB cards needed by the cal-track matching system, including spares.											
M&S Labor BOE- Same engineer as in run2a will be responsible for procurement and has all records of prices and vendors. M&S labor = 12.8h of EEU = \$153.09 M&S labor pays 20% of EEU salary + ere + overhead, university 80%											
M&S Equipment BOE- See BOE binder for detailed itemization of costs. Based on run2a MTFB costs plus a new FPGA 11 boards @ \$770 = \$8470											
M&S total = \$8623.09											
1.2.2.7.8	Fabricate and assemble MTFB	7/14/03	9/8/03	\$6,259	\$287	\$0	\$6,546				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngU	5%	\$0	\$0	\$0	\$0	16 h	0 h	0 h	0 h	16 h
15	MandS	6,546.04	\$6,546	\$0	\$0	\$6,546	6,546.04		0	0	6,546.04
<u>Notes</u> WBS Definition- Fabricate 11 MTFB cards, including 2 spares											
M&S Labor BOE- Same engineer as in run2a will be responsible for tracking the fabrication and assembly. M&S labor = 24h of EEU = \$287.04 M&S labor pays 20% of EEU salary + ere + overhead, university 80%											
M&S Equipment BOE- 11 boards @ \$569 = \$6259											
Unit costs based on actual costs of MTFB assembly * 1.1. Assembly costs were \$72/board plus NRE charges. Fabrication costs are the average of 2 quotes. See BOE binder for run2a po and quotes											
M&S total = \$6485.54											
1.2.2.7.9	Fabrication and Assembly of L1 Trigger Cal-Trk M	9/8/03	9/8/03	\$0	\$0	\$0	\$0				
<u>Notes</u> WBS Definition- milestone: to track production status of MTFB's											
1.2.2.7.10	Test MTFB	9/9/03	11/3/03	\$0	\$2,788	\$0	\$2,788				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngU	10%	\$0	\$0	\$0	\$0	32 h	0 h	0 h	0 h	32 h
8	ElecTechU	60%	\$0	\$0	\$0	\$0	192 h	0 h	0 h	0 h	192 h
10	PhysicistU	20%	\$0	\$0	\$0	\$0	64 h	0 h	0 h	0 h	64 h
15	MandS	2,787.52	\$2,788	\$0	\$0	\$2,788	2,787.52		0	0	2,787.52
<u>Notes</u> WBS Definition Test functionality of MTFB cards on the Level1 muon test stand.											

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																																													
"Test MTFB" continued																																																																				
<u>Notes</u> M&S Labor BOE- Based on Run2a MTFB rate of 1 board/day (full time) plus additional time for trouble-shooting M&S labor = 32h of EEU and 192h of ETU = \$2787.52 M&S labor pays 20% of EEU salary + ere + overhead, university 80% M&S labor pays full ETU salary + ere + overhead  M&S Equipment BOE- There are no M&S equipment costs associated with this task  M&S total = \$2787.52																																																																				
1.2.2.8	Infrastructure	12/2/02	2/9/04	\$70,058	\$4,761	\$29,640	\$104,459																																																													
<u>Notes</u> WBS Definition- This summary element includes various infrastructure components such as cabling, crates, backplanes and power supplies.																																																																				
1.2.2.8.1	Procure cables and connectors	3/20/03	7/11/03	\$16,410	\$230	\$0	\$16,639																																																													
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>3%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>19.2 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>19.2 h</td></tr><tr><td>15</td><td>MandS</td><td>16,639.36</td><td>\$16,639</td><td>\$0</td><td>\$0</td><td>\$16,639</td><td>16,639.36</td><td></td><td>0</td><td>0</td><td>16,639.36</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	3%	\$0	\$0	\$0	\$0	19.2 h	0 h	0 h	0 h	19.2 h	15	MandS	16,639.36	\$16,639	\$0	\$0	\$16,639	16,639.36		0	0	16,639.36																															
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																									
4	ElecEngU	3%	\$0	\$0	\$0	\$0	19.2 h	0 h	0 h	0 h	19.2 h																																																									
15	MandS	16,639.36	\$16,639	\$0	\$0	\$16,639	16,639.36		0	0	16,639.36																																																									
<u>Notes</u> WBS Definition- Procure the cables and connectors needed by the cal-track matching system including spares.  M&S Labor BOE- Approximately 3 days of work to re-order cables and connectors that were used in the run2a Level 1 muon trigger. M&S labor = 19.2h of EEU = \$229.63 M&S labor pays 20% of EEU salary + ere + overhead, university 80%  M&S Equipment BOE- Run 2a costs x 1.1. See BOE binder for Run 2a PO's. See xls spreadsheet for connector details Costs are connector for one end plus connector for the other end plus 1/8 connector shell costs are for cables from the "front ends" to the splitter cards (bnc to sma) and from the splitter cards to the mtcxx cards (conec to conec) and on board the mtcxx cards (conec to mcx). M&S Equipment total = \$16409.63  M&S total = \$16639.36																																																																				
1.2.2.8.2	Assemble cables	7/14/03	10/6/03	\$0	\$601	\$9,360	\$9,961																																																													
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>7</td><td>ElecTechF</td><td>50%</td><td>\$9,360</td><td>\$0</td><td>\$0</td><td>\$9,360</td><td>240 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>240 h</td></tr><tr><td>8</td><td>ElecTechU</td><td>20%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>96 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>96 h</td></tr><tr><td>10</td><td>PhysicistU</td><td>25%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>120 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>120 h</td></tr><tr><td>15</td><td>MandS</td><td>601.2</td><td>\$601</td><td>\$0</td><td>\$0</td><td>\$601</td><td>601.2</td><td></td><td>0</td><td>0</td><td>601.2</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	7	ElecTechF	50%	\$9,360	\$0	\$0	\$9,360	240 h	0 h	0 h	0 h	240 h	8	ElecTechU	20%	\$0	\$0	\$0	\$0	96 h	0 h	0 h	0 h	96 h	10	PhysicistU	25%	\$0	\$0	\$0	\$0	120 h	0 h	0 h	0 h	120 h	15	MandS	601.2	\$601	\$0	\$0	\$601	601.2		0	0	601.2							
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																									
7	ElecTechF	50%	\$9,360	\$0	\$0	\$9,360	240 h	0 h	0 h	0 h	240 h																																																									
8	ElecTechU	20%	\$0	\$0	\$0	\$0	96 h	0 h	0 h	0 h	96 h																																																									
10	PhysicistU	25%	\$0	\$0	\$0	\$0	120 h	0 h	0 h	0 h	120 h																																																									
15	MandS	601.2	\$601	\$0	\$0	\$601	601.2		0	0	601.2																																																									
<u>Notes</u> WBS Definition Assemble cables at Fermilab and a smaller number at arizona eg the first couple sets would be done at arizona to determine length and test procedure.  Labor BOE- Based on Run 2a experience of 2 complete cables per hour (cutting, termination, testing, rework, labeling).  M&S labor = 48h of ETU = \$601.20 M&S labor pays full ETU salary + ere + overhead  M&S total = \$601.20																																																																				
1.2.2.8.3	Procure VME crates	12/2/02	6/12/03	\$8,600	\$373	\$0	\$8,973																																																													
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>8</td><td>ElecTechU</td><td>3%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>31.2 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>31.2 h</td></tr><tr><td>15</td><td>MandS</td><td>8,973.15</td><td>\$8,973</td><td>\$0</td><td>\$0</td><td>\$8,973</td><td>8,973.15</td><td></td><td>0</td><td>0</td><td>8,973.15</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	8	ElecTechU	3%	\$0	\$0	\$0	\$0	31.2 h	0 h	0 h	0 h	31.2 h	15	MandS	8,973.15	\$8,973	\$0	\$0	\$8,973	8,973.15		0	0	8,973.15																															
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																									
8	ElecTechU	3%	\$0	\$0	\$0	\$0	31.2 h	0 h	0 h	0 h	31.2 h																																																									
15	MandS	8,973.15	\$8,973	\$0	\$0	\$8,973	8,973.15		0	0	8,973.15																																																									



WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																
"Procure VME crates" continued																																							
<u>Notes</u> WBS Definition- Procure two custom VME crates for MTCxx cards for cal-trk match.  M&S Labor BOE Mostly waiting for order to be filled; about 3/4 of a week total interacting with vendor. The crate is special-ordered by Tre New through Electronic Solutions. M&S labor = 31.2h of EEU = \$373.15 M&S labor pays 20% of EEU salary + ere + overhead, university 80%  M&S Equipment BOE- See BOE binder for vendor quote M&S equipment total = 2 x \$4300 = \$8600  M&S total = \$8973.15																																							
1.2.2.8.4	Procure VME processors	3/20/03	9/22/03	\$8,368	\$124	\$0	\$8,492																																
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>1%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>10.4 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>10.4 h</td></tr><tr><td>15</td><td>MandS</td><td>8,492.38</td><td>\$8,492</td><td>\$0</td><td>\$0</td><td>\$8,492</td><td>8,492.38</td><td></td><td>0</td><td>0</td><td>8,492.38</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	1%	\$0	\$0	\$0	\$0	10.4 h	0 h	0 h	0 h	10.4 h	15	MandS	8,492.38	\$8,492	\$0	\$0	\$8,492	8,492.38		0	0	8,492.38		
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																												
4	ElecEngU	1%	\$0	\$0	\$0	\$0	10.4 h	0 h	0 h	0 h	10.4 h																												
15	MandS	8,492.38	\$8,492	\$0	\$0	\$8,492	8,492.38		0	0	8,492.38																												
<u>Notes</u> WBS Definition- Procure 3 6u embedded processors and form factor adapters for control and downloading of the MTCxx crates.  M&S Labor BOE- One day to place order and follow up. M&S labor = 10.4h of EEU = \$124.38 M&S labor pays 20% of EEU salary + ere + overhead, university 80%  M&S Equipment BOE- See BOE binder for vendor quote = 2 processors @ 3655 = 7310 Form adaptors are 2 x \$529 = \$1058 from run 2a experience M&S equipment total = \$8368  M&S total = \$8434.38																																							
1.2.2.8.5	Procure power supplies	1/23/03	7/25/03	\$13,565	\$124	\$0	\$13,690																																
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>1%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>10.4 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>10.4 h</td></tr><tr><td>15</td><td>MandS</td><td>13,689.58</td><td>\$13,690</td><td>\$0</td><td>\$0</td><td>\$13,690</td><td>13,689.58</td><td></td><td>0</td><td>0</td><td>13,689.58</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	1%	\$0	\$0	\$0	\$0	10.4 h	0 h	0 h	0 h	10.4 h	15	MandS	13,689.58	\$13,690	\$0	\$0	\$13,690	13,689.58		0	0	13,689.58		
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																												
4	ElecEngU	1%	\$0	\$0	\$0	\$0	10.4 h	0 h	0 h	0 h	10.4 h																												
15	MandS	13,689.58	\$13,690	\$0	\$0	\$13,690	13,689.58		0	0	13,689.58																												
<u>Notes</u> WBS Definition- Procure power supplies for MTCxx crate.  M&S Labor BOE- Mostly waiting for order to be filled; about one day of getting quotes, placing order, and follow-up M&S labor = 10.4h of EEU = \$124.38 M&S labor pays 20% of EEU salary + ere + overhead, university 80%  M&S Equipment BOE- Vendor quote x 1.1 (see BOE binder) Price is for 4 supplies including 2 spares @\$3391.3 They are packaged as 2 x 2 supplies each = \$13565.2  M&S total = \$13689.58																																							
1.2.2.8.6	Assemble and test power supplies	7/28/03	2/9/04	\$4,180	\$124	\$20,280	\$24,584																																
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>1%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>10.4 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>10.4 h</td></tr><tr><td>7</td><td>ElecTechF</td><td>50%</td><td>\$20,280</td><td>\$0</td><td>\$0</td><td>\$20,280</td><td>520 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>520 h</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	1%	\$0	\$0	\$0	\$0	10.4 h	0 h	0 h	0 h	10.4 h	7	ElecTechF	50%	\$20,280	\$0	\$0	\$20,280	520 h	0 h	0 h	0 h	520 h		
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																												
4	ElecEngU	1%	\$0	\$0	\$0	\$0	10.4 h	0 h	0 h	0 h	10.4 h																												
7	ElecTechF	50%	\$20,280	\$0	\$0	\$20,280	520 h	0 h	0 h	0 h	520 h																												

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name					Start	Finish		M&S EQ	M&S Labor	FNAL Labor	Total Cost	
"Assemble and test power supplies" continued													
	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	
	10	PhysicistU	10%	\$0	\$0	\$0	\$0	104 h	0 h	0 h	0 h	104 h	
	15	MandS	4,304.38	\$4,304	\$0	\$0	\$4,304	4,304.38		0	0	4,304.38	
	<u>Notes</u>												
	WBS Definition- Assemble and test power supplies for MTCxx crates.												
	M&S Labor BOE- Run 2a supplies took about 1 month per supply on average to assemble and test with a full-time technician assigned to the task needed for parts ordering is 10.4h of ElecEngU = \$124.38 in addition to ElecTechF. Some parts are orded by the ElecTechF from the fermilab stockroom.												
	M&S Equipment BOE- Costs were estimated using run 2a costs There is some uncertainty as to whether we must re-order the display and monitor PCB's. See BOE binder for a spreadsheet of the costs. Basically i added many/most of the costs for 6 crates and divided by 6. 2 supply cases (each containing 2 supplies) will be built at \$2190 / case. This includes display and monitor electronics. M&S equipment total = \$4180												
	M&S total = \$4304.38												
1.2.2.8.7	Procure MSPLIT crates, backplanes, and power suppl						6/2/03	9/23/03		\$409	\$401	\$0	\$810
	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	
	8	ElecTechU	5%	\$0	\$0	\$0	\$0	32 h	0 h	0 h	0 h	32 h	
	15	MandS	809.6	\$810	\$0	\$0	\$810	809.6		0	0	809.6	
	<u>Notes</u>												
	WBS Definition Procure crate, power backplane, and power supplies for MSPLIT cards for MTCxx cards.												
	M&S Labor BOE- Same ElecTechU who ordered parts for run2a will do so again for run 2b. M&S labor = 32h of ETU = \$400.80 M&S labor pays ETU salary + ere + overhead The backplanes will be spares from Run 2a but they must be assembled by the ElecTechU.												
	M&S Equipment BOE- See BOE binder. Based on run 2a costs x 1.1 except the power supply which we estimate using the supply catalog price. M&S equipment total = \$408.80												
	M&S total = \$809.60												
1.2.2.8.8	Procure MSPLIT card parts						5/15/03	8/8/03		\$7,207	\$301	\$0	\$7,508
	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	
	4	ElecEngU	5%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h	
	15	MandS	7,507.8	\$7,508	\$0	\$0	\$7,508	7,507.8		0	0	7,507.8	
	<u>Notes</u>												
	WBS Definition- Procure the parts needed for MSPLIT cards												
	M&S Labor BOE- Same ElecTechU as in run2a will be responsible for procurement and has all records of prices and vendors. M&S labor = 24h of EEU = \$300.6 M&S labor pays ETU salary + ere + overhead												
	M&S Equipment BOE See BOE binder for spreadsheet. Cost based on Run2a MSPLIT costs x 1.1 14 boards @ \$514.8 = \$7207.2												
	M&S total = \$7507.8												

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.2.8.9	Fabricate and assemble MSPLIT cards	8/11/03	11/3/03	\$11,319	\$1,489	\$0	\$12,808
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 5% \$0 \$0 \$0 \$0 24 h 0 h 0 h 0 h 24 h						
	8 ElecTechU 20% \$0 \$0 \$0 \$0 96 h 0 h 0 h 0 h 96 h						
	15 MandS 12,808.44 \$12,808 \$0 \$0 \$12,808 12,808.44 0 0 12,808.44						
	<i>Notes</i> WBS Definition- Fabricate 14 splitter cards including 2 spares.  M&S Labor BOE Same engineer as in Run 2a will be responsible for tracking the fabrication and assembly. Same ElecTechU as in Run 2a will do the assembly. The full-time assembly rate in Run 2a was 1 board per day. M&S labor = 24h of EEU and 96h of ETU= \$1489.44 M&S labor pays 20% of EEU salary + ere + overhead M&S labor pays full ETU salary + ere + overhead  M&S Equipment BOE- 14 boards @ \$808.5 = \$11319  Unit costs based on actual costs of run2a MSPLIT fabrication x 1.1. Assembly will be by Arizona technician. See BOE binder for run2a p.o.  M&S total = \$12808.44						
1.2.2.8.10	Test MSPLIT cards	11/4/03	1/9/04	\$0	\$993	\$0	\$993
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 5% \$0 \$0 \$0 \$0 16 h 0 h 0 h 0 h 16 h						
	8 ElecTechU 20% \$0 \$0 \$0 \$0 64 h 0 h 0 h 0 h 64 h						
	10 PhysicistU 5% \$0 \$0 \$0 \$0 16 h 0 h 0 h 0 h 16 h						
	15 MandS 992.96 \$993 \$0 \$0 \$993 992.96 0 0 992.96						
	<i>Notes</i> WBS Definition- Test functionality of MSPLIT cards on existing run2a test stand.  M&S Labor BOE- Based on Run2a MSPLIT rate of 2 boards/day (full time) for complete testing. Additional time needed for debugging and fixes. M&S labor = 16h of EEU and 64h of ETU = \$992.96 M&S labor pays 20% of EEU salary + ere + overhead M&S labor pays full ETU salary + ere + overhead  M&S Equipment BOE- There are no M&S equipment costs associated with this task.  M&S total = \$992.96						
1.2.2.9	L1 Trigger Cal-Trk Match Production and Testing C	7/14/04	7/14/04	\$0	\$0	\$0	\$0
	<i>Notes</i> WBS Definition- milestone: track matching system complete except for intallation and commissioning						
1.2.3	Level 1 Tracking	11/12/02	3/16/05	\$569,208	\$242,995	\$57,980	\$870,183
	<i>Notes</i> WBS Definition- This summary element provides for improvements in the existing track trigger. It includes design and development of algorithms that utilize larger FPGAs, and development and procurement of new Digital Front-End (DFE) boards that utilize these FPGAs.						
1.2.3.1	Prototype L1 Central Track Trigger Algorithm Code	11/12/02	11/12/02	\$0	\$0	\$0	\$0
	<i>Notes</i> WBS Definition- milestone: once this is done, FPGAs can be chosen						

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																				
1.2.3.2	Develop Target CTT Algorithm	11/13/02	7/17/03	\$0	\$85,272	\$0	\$85,272																																				
<div>Notes</div> <div>WBS Definition- Develop VHDL code for the FPGA's to implement the track finding equations and othe board functions.</div>																																											
1.2.3.2.1	Develop firmware for target CTT algorithm	11/13/02	6/11/03	\$0	\$72,352	\$0	\$72,352																																				
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>100%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>1,120 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>1,120 h</td></tr><tr><td>15</td><td>MandS</td><td>72,352</td><td>\$72,352</td><td>\$0</td><td>\$0</td><td>\$72,352</td><td>72,352</td><td></td><td>0</td><td>0</td><td>72,352</td></tr></table> <div>Notes</div> <div>WBS Definition- Design the DFEA board firmware to use more powerful FPGA's and provide the outputs to l1muon and l2ctt.</div> <div>Labor BOE- The engineer who designed run2a STC trigger flavor board will be doing the design. The STC board is similar in complexity and took us 6 months to complete the firmware. The current work estimate was increased by a month for the engineer to get familiar with the cabling and the input structure (which is fairly complex) to the DFEA.</div> <div>M&amp;S BOE- Labor charges based on at the BU EDF rate of \$40/hr and an overhead of 61.5%.</div>								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	100%	\$0	\$0	\$0	\$0	1,120 h	0 h	0 h	0 h	1,120 h	15	MandS	72,352	\$72,352	\$0	\$0	\$72,352	72,352		0	0	72,352
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
4	ElecEngU	100%	\$0	\$0	\$0	\$0	1,120 h	0 h	0 h	0 h	1,120 h																																
15	MandS	72,352	\$72,352	\$0	\$0	\$72,352	72,352		0	0	72,352																																
1.2.3.2.2	Fit CTT firmware in selected FPGA, do timing studies	6/12/03	7/17/03	\$0	\$12,920	\$0	\$12,920																																				
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>100%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>200 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>200 h</td></tr><tr><td>15</td><td>MandS</td><td>12,920</td><td>\$12,920</td><td>\$0</td><td>\$0</td><td>\$12,920</td><td>12,920</td><td></td><td>0</td><td>0</td><td>12,920</td></tr></table> <div>Notes</div> <div>WBS Definition- Understand the resources used by the L1CTT algorithm for all 4 pt bins, the input and the ouptut result sort leading to the selection of the FPGA to be used. Timing studies need to be carried out to make sure the algorithm and associated overhead fits in the specified 790ns window.</div> <div>Labor BOE- The resource allocation, FPGA selection and the timing studies /tuning of the firware will be done by the same engineer who worked on the STC. This task took 3 weeks for the STC. We have added 2 more weeks due to the increased complexity of the L1CTT design.</div> <div>M&amp;S BOE- Labor charges based on at the BU EDF rate of \$40/hr and an overhead of 61.5%.</div>								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	100%	\$0	\$0	\$0	\$0	200 h	0 h	0 h	0 h	200 h	15	MandS	12,920	\$12,920	\$0	\$0	\$12,920	12,920		0	0	12,920
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
4	ElecEngU	100%	\$0	\$0	\$0	\$0	200 h	0 h	0 h	0 h	200 h																																
15	MandS	12,920	\$12,920	\$0	\$0	\$12,920	12,920		0	0	12,920																																
1.2.3.3	Target L1 Central Track Trigger Algorithm Firmwar	7/17/03	7/17/03	\$0	\$0	\$0	\$0																																				
<div>Notes</div> <div>WBS Definition- milestone:</div>																																											
1.2.3.4	Develop Test Procedures	7/18/03	8/28/03	\$0	\$1,550	\$0	\$1,550																																				
<div>Notes</div> <div>WBS Definition- Develop test procedure code, based on Run2a. The test procedures for testing the full functionality of the prototype boards will be developed. We will use the same test stand hardware as used for the Run2a DFEA tests. However, since the internals of the firmware will be changed, the test procedures have to be rewritten. The specifications for the test procedure will be defined by the engineer who develops the firmware.</div>																																											
1.2.3.4.1	Develop test procedures	7/18/03	8/28/03	\$0	\$1,550	\$0	\$1,550																																				
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>10%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>24 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>24 h</td></tr><tr><td>15</td><td>MandS</td><td>1,550.4</td><td>\$1,550</td><td>\$0</td><td>\$0</td><td>\$1,550</td><td>1,550.4</td><td></td><td>0</td><td>0</td><td>1,550.4</td></tr></table> <div>Notes</div> <div>WBS Definition- Develop test procedure code, based on Run2a</div> <div>Labor BOE- The specifications for the test procedure will be defined by the engineer who develops the firmware, together with a BU physicist. The estimate of engineering fraction is based on hours spent by the engineer for the STC test procedure developments.</div>								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	10%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h	15	MandS	1,550.4	\$1,550	\$0	\$0	\$1,550	1,550.4		0	0	1,550.4
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
4	ElecEngU	10%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h																																
15	MandS	1,550.4	\$1,550	\$0	\$0	\$1,550	1,550.4		0	0	1,550.4																																

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost				
"Develop test procedures" continued											
<div>Notes</div> <div>M&amp;S Labor BOE- Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.</div>											
1.2.3.4.2	Develop test procedures	7/18/03	8/28/03	\$0	\$0	\$0	\$0				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	PhysicistU	100%	\$0	\$0	\$0	\$0	240 h	0 h	0 h	0 h	240 h
<div>Notes</div> <div>WBS Definition- Develop test procedure code, based on Run2a</div> <div>Labor BOE- The specifications for the test procedure will be defined by the engineer who develops the firmware together with a BU physicist. Engineering effort is assigned to the previous task (1.2.3.4.1)</div>											
1.2.3.5	DFEA Prototype I	7/18/03	2/20/04	\$56,089	\$50,259	\$0	\$106,348				
<div>Notes</div> <div>WBS Definition- Design and build complete functional prototypes for the Digital Front-End Axial daughter boards.</div>											
1.2.3.5.1	Layout	7/18/03	9/12/03	\$0	\$22,739	\$0	\$22,739				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngU	100%	\$0	\$0	\$0	\$0	320 h	0 h	0 h	0 h	320 h
8	ElecTechU	10%	\$0	\$0	\$0	\$0	32 h	0 h	0 h	0 h	32 h
15	MandS	22,739	\$22,739	\$0	\$0	\$22,739	22,739		0	0	22,739
<div>Notes</div> <div>WBS Definition- Lay out prototype 1 of DFEA.</div> <div>Labor BOE- Run2a STC card layout experience. It took about 5 weeks for layout and verification for the STC card. DFEA will have chips with a factor of 2 output pins on the FPGAs as well as the board layout will be more complex - so we have added 3 more weeks to this phase.</div> <div>M&amp;S BOE- Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.</div>											
1.2.3.5.2	Procure prototype DFEA FPGAs	7/18/03	10/10/03	\$48,000	\$0	\$0	\$48,000				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	MandS	48,000	\$48,000	\$0	\$0	\$48,000	48,000		0	0	48,000
<div>Notes</div> <div>WBS Definition- Procure the Xilinx chips for assembly of 6 prototype DFEA. We will assemble only 3 boards for the prototype I round, and 3 in the second. However since the lead times are large, procuring the FPGA all during the first round is necessary and buying more than 10 at a time generally is 10-15% cheaper than 9 or less chips.</div> <div>Labor BOE- n/a</div> <div>M&amp;S BOE - Cost for 24 XC2V6000 FPGA, based on 2000\$ per FPGA. If the FPGA prices remain high at the time of purchase, we will prototype a scaled-down version of the board with 2 pT bins instead of 4. See supporting document in BOE binder.</div>											
1.2.3.5.3	Procure prototype DFEA FPGAs	7/18/03	10/10/03	\$0	\$0	\$0	\$0				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	PhysicistU	2%	\$0	\$0	\$0	\$0	9.6 h	0 h	0 h	0 h	9.6 h
<div>Notes</div> <div>WBS Definition- Procure theXilinx chips for assembly of 6 prototype DFEA. We will assemble only 3 boards for the prototype I round, and 3 in the second. However since the lead times are large, procuring the FPGA all during</div>											

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost					
"Procure prototype DFEA FPGAs" continued												
<u>Notes</u> the first round is necessary and buying more than 10 at a time generally is 10-15% cheaper than 9 or less chips.												
Labor BOE- n/a												
M&S BOE - see previous task												
1.2.3.5.4	Procure prototype DFEA parts	9/15/03	10/10/03	\$0	\$2,067	\$0	\$2,067					
	<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
	8	ElecTechU	20%	\$0	\$0	\$0	\$0	32 h	0 h	0 h	0 h	32 h
	15	MandS	2,067.2	\$2,067	\$0	\$0	\$2,067	2,067.2		0	0	2,067.2
<u>Notes</u> WBS Definition- Procure the parts for building two prototype DFEA.												
Labor BOE- BU technical staff will be responsible for procurement of parts and has experience for procuring parts for the Run1a STC. Estimate based on time spent to order STC parts.												
M&S BOE - Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.												
1.2.3.5.5	Procure prototype DFEA parts	9/15/03	10/10/03	\$1,500	\$0	\$0	\$1,500					
	<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
	15	MandS	1,500	\$1,500	\$0	\$0	\$1,500	1,500		0	0	1,500
<u>Notes</u> WBS Definition- Procure the parts for building two prototype DFEA.												
Labor BOE- n/a												
M&S BOE - Cost based on per board prototype parts for the STC - \$750/board.												
1.2.3.5.6	PCB fabrication	10/13/03	10/24/03	\$0	\$1,034	\$0	\$1,034					
	<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
	8	ElecTechU	20%	\$0	\$0	\$0	\$0	16 h	0 h	0 h	0 h	16 h
	15	MandS	1,033.6	\$1,034	\$0	\$0	\$1,034	1,033.6		0	0	1,033.6
<u>Notes</u> WBS Definition- PCB fabrication of the DFEA board at vendor site.												
Labor BOE- Based on Run2a STC - includes collecting the files needed by the vendor for PCB fabrication, and to be done by the same person as for the STC.												
M&S BOE - Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.												
1.2.3.5.7	PCB fabrication	10/13/03	10/24/03	\$5,801	\$0	\$0	\$5,801					
	<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
	15	MandS	5,801	\$5,801	\$0	\$0	\$5,801	5,801		0	0	5,801
<u>Notes</u> WBS Definition- PCB fabrication of the DFEA board at vendor site												
Labor BOE-												

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"PCB fabrication" continued							
<u>Notes</u> n/a							
M&S BOE - Based on Run2a STC vendor quote - \$3731+240+450 + 1080+300 = 5801. Includes bare board, stencil, tooling, test, Stencil -NRE, programming-NRE. See BOE binder.							
1.2.3.5.8	Assembly	10/27/03	11/14/03	\$0	\$1,163	\$0	\$1,163
	<u>ID</u> <u>Resource Name</u> <u>Units</u> <u>Cost</u> <u>Baseline Cost</u> <u>Act. Cost</u> <u>Rem. Cost</u> <u>Work</u> <u>Ovt. Work</u> <u>Baseline Work</u> <u>Act. Work</u> <u>Rem. Work</u>						
	8 ElecTechU 15% \$0 \$0 \$0 \$0 18 h 0 h 0 h 0 h 18 h						
	15 MandS 1,162.8 \$1,163 \$0 \$0 \$1,163 1,162.8 0 0 1,162.8						
<u>Notes</u> WBS Definition- Assembly of the DFEA prototype boards at venodr site.  Labor BOE- Based on Run2a STC - includes collecting the parts needed by the vendor for PCB assembly. Will be done by the same person as STC.  M&S BOE - Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.							
1.2.3.5.9	Assembly	10/27/03	11/14/03	\$788	\$0	\$0	\$788
	<u>ID</u> <u>Resource Name</u> <u>Units</u> <u>Cost</u> <u>Baseline Cost</u> <u>Act. Cost</u> <u>Rem. Cost</u> <u>Work</u> <u>Ovt. Work</u> <u>Baseline Work</u> <u>Act. Work</u> <u>Rem. Work</u>						
	15 MandS 788 \$788 \$0 \$0 \$788 788 0 0 788						
<u>Notes</u> WBS Definition- Assembly of the DFEA prototype boards at vendor site.  M&S BOE - Based on Run2a STC vendor quote - see BOE binder.							
1.2.3.5.10	Test	11/17/03	2/20/04	\$0	\$0	\$0	\$0
	<u>ID</u> <u>Resource Name</u> <u>Units</u> <u>Cost</u> <u>Baseline Cost</u> <u>Act. Cost</u> <u>Rem. Cost</u> <u>Work</u> <u>Ovt. Work</u> <u>Baseline Work</u> <u>Act. Work</u> <u>Rem. Work</u>						
	10 PhysicistU 50% \$0 \$0 \$0 \$0 240 h 0 h 0 h 0 h 240 h						
<u>Notes</u> WBS Definition- DFEA prototype board testing.  Labor BOE- 6 weeks of university physicist.  M&S BOE- n/a							
1.2.3.5.11	Test	11/17/03	2/20/04	\$0	\$23,256	\$0	\$23,256
	<u>ID</u> <u>Resource Name</u> <u>Units</u> <u>Cost</u> <u>Baseline Cost</u> <u>Act. Cost</u> <u>Rem. Cost</u> <u>Work</u> <u>Ovt. Work</u> <u>Baseline Work</u> <u>Act. Work</u> <u>Rem. Work</u>						
	4 ElecEngU 75% \$0 \$0 \$0 \$0 360 h 0 h 0 h 0 h 360 h						
	15 MandS 23,256 \$23,256 \$0 \$0 \$23,256 23,256 0 0 23,256						
<u>Notes</u> WBS Definition- DFEA prototype board testing.  Labor BOE- Based on Run2a STC - It took 3 months of a full time physicist and an engineer working at 75% for testing the first prototypes of the STC.  M&S BOE - Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.							

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.3.6	DFEA Prototype II	12/17/03	4/16/04	\$7,823	\$25,918	\$17,880	\$51,620

Notes

WBS Definition-  
Design and build complete functional prototypes for the Digital Front-End Axial daughter boards.

1.2.3.6.1	Layout					12/17/03		1/23/04		\$0	\$12,920		\$0	\$12,920
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work			
4	ElecEngU	100%	\$0	\$0	\$0	\$0	160 h	0 h	0 h	0 h	160 h			
8	ElecTechU	25%	\$0	\$0	\$0	\$0	40 h	0 h	0 h	0 h	40 h			
15	MandS	12,920	\$12,920	\$0	\$0	\$12,920	12,920		0	0	12,920			

Notes

WBS Definition-  
Modifications to the first layout, uncovered while testing. Any changes which need to be made due to our experience with testing, verification of the new layout.

M&S BOE-  
Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.

Labor BOE-  
Run2a STC card layout experience. Estimate based on time taken for the STC. It took 4 weeks to make the necessary changes and verification of the layout.

1.2.3.6.2	PCB fabrication					1/26/04	2/6/04	\$1,034	\$0	\$0	\$1,034
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
8	ElecTechU	20%	\$0	\$0	\$0	\$0	16 h	0 h	0 h	0 h	16 h
15	MandS	1,033.6	\$1,034	\$0	\$0	\$1,034	1,033.6		0	0	1,033.6

Notes

WBS Definition-  
PCB fabrication of the DFEA board prototype II at vendor site.

Labor BOE-  
Based on Run2a STC - includes collecting the files needed by the vendor for PCB fabrication.

M&S BOE -  
Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.

1.2.3.6.3	PCB fabrication					1/26/04	2/6/04	\$5,801	\$0	\$0	\$5,801	
	<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
	15	MandS	5,801	\$5,801	\$0	\$0	\$5,801	5,801		0	0	5,801

Notes

WBS Definition-  
PCB fabrication of the DFEA board prototype II at vendor site.

Labor BOE-  
n/a

M&S BOE -  
Based on Run2a STC vendor quote - \$3731+240+450 + 1080+300 = 5801. Includes bare board, stencil, tooling, test, Stencil -NRE, programming-NRE- see BOE binder.

1.2.3.6.4	Procure parts for the prototpes					1/16/04	2/6/04	\$200	\$0	\$0	\$200	
	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
	15	MandS	200	\$200	\$0	\$0	\$200	200		0	0	200

Notes

WBS Definition-  
Procure the parts for building two prototype DFEA.

Labor BOE-  
n/a

M&S BOE -  
Cost based on per board prototype parts for the STC during the second round of prototype- \$100/board - as most of the parts would have been bought in the first round of prototype. Resistors, capacitors, voltage



WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost				
"Procure parts for the prototypes" continued											
<u>Notes</u> regulators sometimes need to be bulk ordered.											
1.2.3.6.5	Procure parts for the prototypes	1/16/04	2/6/04	\$0	\$78	\$0	\$78				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
8	ElecTechU	1%	\$0	\$0	\$0	\$0	1.2 h	0 h	0 h	0 h	1.2 h
15	MandS	77.52	\$78	\$0	\$0	\$78	77.52		0	0	77.52
<u>Notes</u> WBS Definition- Procure the parts for building two prototype DFEA.  Labor BOE- BU technical staff will be responsible for procurement of parts and has experience for procuring parts for the Run1a STC.  M&S BOE - Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.											
1.2.3.6.6	Assembly	2/9/04	2/20/04	\$788	\$0	\$0	\$788				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	MandS	788	\$788	\$0	\$0	\$788	788		0	0	788
<u>Notes</u> WBS Definition- Assembly of the DFEA prototype boards at vendor site.  Labor BOE- n/a  M&S BOE - Based on Run2a STC vendor quote - see BOE binder.											
1.2.3.6.7	Assembly	2/9/04	2/20/04	\$0	\$1,034	\$0	\$1,034				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
8	ElecTechU	20%	\$0	\$0	\$0	\$0	16 h	0 h	0 h	0 h	16 h
15	MandS	1,033.6	\$1,034	\$0	\$0	\$1,034	1,033.6		0	0	1,033.6
<u>Notes</u> WBS Definition- Assembly of the DFEA prototype boards at vendor site.  Labor BOE- Based on Run2a STC - includes collecting the parts needed by the vendor for PCB assembly.  M&S BOE - Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.											
1.2.3.6.8	Test	2/23/04	4/16/04	\$0	\$10,336	\$0	\$10,336				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngU	50%	\$0	\$0	\$0	\$0	160 h	0 h	0 h	0 h	160 h
15	MandS	10,336	\$10,336	\$0	\$0	\$10,336	10,336		0	0	10,336
<u>Notes</u> WBS Definition- DFEA prototype II board testing  M&S BOE - Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.  Labor BOE- Based on Run2a STC - Initial tests took 2 months of a full time physicist for testing the second prototypes of the STC. This included processing several events for a stress test of the system. The engineer was involved half time and worked together with the physicist to certify that we are ready for production. We will follow the same model here, as it worked well for Run2a STC.											

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.3.6.9	Test	2/23/04	4/16/04	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 100% \$0 \$0 \$0 \$0 320 h 0 h 0 h 0 h 320 h						
	<u>Notes</u> WBS Definition- DFEA prototype II board testing. Includes processing several events for a stress test of the system.  Labor BOE- 8 weeks of a university physicist.  M&S BOE - n/a						
1.2.3.6.10	Test at Fermilab	3/8/04	4/16/04	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 100% \$0 \$0 \$0 \$0 240 h 0 h 0 h 0 h 240 h						
	<u>Notes</u> WBS Definition- Test prototypes in special runs in the real Dzero trigger. Stress test done by physicist.  Labor BOE- 6 weeks of a university physicist  M&S BOE- n/a						
1.2.3.6.11	Test at Fermilab	3/8/04	4/16/04	\$0	\$1,550	\$0	\$1,550
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 10% \$0 \$0 \$0 \$0 24 h 0 h 0 h 0 h 24 h						
	15 MandS 1,550.4 \$1,550 \$0 \$0 \$1,550 1,550.4 0 0 0 1,550.4						
	<u>Notes</u> WBS Definition- Test prototypes in special runs in the real Dzero trigger.  Labor BOE- This will be a first test of the DFEA boards at Fermilab. The DFEA boards will be tested using the modified Run2a DFEA infrastructure. This setup will be a collaboration between engineer at FNAL, technical person at FNAL, and a physicist who has been involved in the prototype testing. The BU engineer who designed the board will act as a consultant to get the FNAL stand running.  M&S BOE- Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.						
1.2.3.6.12	Test at Fermilab	3/8/04	4/16/04	\$0	\$0	\$17,880	\$17,880
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	3 ElecEngF 100% \$13,200 \$0 \$0 \$13,200 240 h 0 h 0 h 0 h 240 h						
	7 ElecTechF 50% \$4,680 \$0 \$0 \$4,680 120 h 0 h 0 h 0 h 120 h						
	<u>Notes</u> WBS Definition- Test prototypes in special runs in the real Dzero trigger.  Labor BOE- This will be a first test of the DFEA boards at Fermilab. The DFEA boards will be tested using the modified Run2a DFEA infrastructure. This task holds the FNAL elec engineering and elec tech portion of the labor for that testing task.						
1.2.3.6.13	Test at Fermilab	3/8/04	4/16/04	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 100% \$0 \$0 \$0 \$0 240 h 0 h 0 h 0 h 240 h						

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost				
"Test at Fermilab " continued											
<div>Notes</div> <div>WBS Definition- Test prototypes in special runs in the real Dzero trigger.</div> <div>Labor BOE- This will be a first test of the DFEA boards at Fermilab. The DFEA boards will be tested using the modified Run2a DFEA infrastructure. There will be physicist which will be trained on testing the boards using the FNAL test stand. They will be involved in testing the production setup. This task holds the KU physicist labor.</div>											
1.2.3.6.14	Test at Fermilab	3/8/04	4/16/04	\$0	\$0	\$0	\$0				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	PhysicistU	100%	\$0	\$0	\$0	\$0	240 h	0 h	0 h	0 h	240 h
<div>Notes</div> <div>WBS Definition- Test prototypes in special runs in the real Dzero trigger</div> <div>Labor BOE- This will be a first test of the DFEA boards at Fermilab. The DFEA boards will be tested using the modified Run2a DFEA infrastructure. There will be physicist which will be trained on testing the boards using the FNAL test stand. They will be involved in testing the production setup. This task holds the ND physicist labor.</div>											
1.2.3.6.15	L1 Central Track Trigger DFEA Prototype Tested A	4/16/04	4/16/04	\$0	\$0	\$0	\$0				
<div>Notes</div> <div>WBS Definition- milestone:</div>											
1.2.3.7	DFEA Production	4/19/04	3/16/05	\$505,296	\$79,996	\$40,100	\$625,392				
<div>Notes</div> <div>WBS Definition- This summary task covers the production of the final version of the DFEA's.</div> <div>Risk Mitigation- Cost: There are 3 factors which may affect the "Cost": 1) Xilinx chip prices may not completely follow vendor projected quote. 2) We may need XC2V8000 chips due to equation growth when we put in effects of various inefficiencies and misalignments in the modeling of the CFT in the simulations. 3) The board will use parts which are a factor of 2.5 denser and complicated than the current Run2a DFEA boards. This may lead to higher vendor quotes for PCB fabrication and assembly compared to Run2a quotes included in the BOE.  All of these factors may lead to a cost increase which is a significant fraction of project cost. We have address these risks by including a 70% contingency on the XC2V FPGA costs, a 30%contingency on the PCB fabrication, and a 50% contingency on the production parts.</div>											
1.2.3.7.1	Procure FPGAs	5/24/04	10/13/04	\$356,000	\$0	\$0	\$356,000				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	MandS	356,000	\$356,000	\$0	\$0	\$356,000	356,000		0	0	356,000
<div>Notes</div> <div>WBS Definition- Procure the FPGAs needed for implementing the target algorithm. This is delayed until needed in order to take advantage of price reductions with time.</div> <div>Labor BOE- n/a</div> <div>M&amp;S BOE- Procure the XC2V FPGAs for all 88 boards (80+8 spares). vendor quote, BOE binder.</div>											
1.2.3.7.2	Procure FPGAs	5/24/04	10/13/04	\$83,296	\$0	\$0	\$83,296				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	MandS	83,296	\$83,296	\$0	\$0	\$83,296	83,296		0	0	83,296
<div>Notes</div> <div>WBS Definition- Procure the FPGAs needed for implementing the target algorithm. This is delayed until needed in order to take advantage of price reductions with time.</div>											

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost				
"Procure FPGAs" continued											
<u>Notes</u>											
Labor BOE- n/a											
M&S BOE- Procure the XC2V FPGAs for all 88 boards (80+8 spares). vendor quote, BOE binder.											
1.2.3.7.3	Procure FPGAs	4/26/04	9/15/04	\$0	\$517	\$0	\$517				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
8	ElecTechU	1%	\$0	\$0	\$0	\$0	8 h	0 h	0 h	0 h	8 h
15	MandS	516.8	\$517	\$0	\$0	\$517	516.8		0	0	516.8
<u>Notes</u>											
WBS Definition- Procure the FPGAs needed for implementing the target algorithm. This is delayed until needed in order to take advantage of price reductions with time.											
Labor BOE- Run2a experience - placing the order and negotiating lead times - same time as spent ordering Run2a STC Xilinx chips.											
M&S BOE- Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.											
1.2.3.7.21	Production readiness review	4/19/04	4/23/04	\$0	\$1,292	\$1,100	\$2,392				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
3	ElecEngF	50%	\$1,100	\$0	\$0	\$1,100	20 h	0 h	0 h	0 h	20 h
4	ElecEngU	50%	\$0	\$0	\$0	\$0	20 h	0 h	0 h	0 h	20 h
10	PhysicistU	100%	\$0	\$0	\$0	\$0	40 h	0 h	0 h	0 h	40 h
15	MandS	1,292	\$1,292	\$0	\$0	\$1,292	1,292		0	0	1,292
<u>Notes</u>											
WBS Definition- Review and sign-off process prior to entering into production of the Digital Front-End Axial boards.											
1.2.3.7.4	Design, layout	4/26/04	5/21/04	\$0	\$10,336	\$0	\$10,336				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngU	50%	\$0	\$0	\$0	\$0	80 h	0 h	0 h	0 h	80 h
8	ElecTechU	50%	\$0	\$0	\$0	\$0	80 h	0 h	0 h	0 h	80 h
15	MandS	10,336	\$10,336	\$0	\$0	\$10,336	10,336		0	0	10,336
<u>Notes</u>											
WBS Definition- Make any necessary modifications to prototype II design.											
M&S BOE- Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.											
Labor BOE- Modification of production layout, checking of all layouts based on Run2a STC experience. It took 4 weeks for the final STC production layout and verification. We use the same estimate here.											
1.2.3.7.5	Procure production parts	5/24/04	7/6/04	\$0	\$1,550	\$0	\$1,550				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
8	ElecTechU	10%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h
15	MandS	1,550.4	\$1,550	\$0	\$0	\$1,550	1,550.4		0	0	1,550.4
<u>Notes</u>											
WBS Definition- Procure the parts for building 88 production DFEA.											
Labor BOE- BU technical staff will be responsible for procurement of parts and has experience for procuring parts for the Run1a STC.											

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost				
"Procure production parts" continued											
<u>Notes</u> M&S BOE - Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.											
1.2.3.7.6	Procure production parts	5/24/04	7/6/04	\$17,600	\$0	\$0	\$17,600				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	MandS	17,600	\$17,600	\$0	\$0	\$17,600	17,600		0	0	17,600
<u>Notes</u> WBS Definition- Procure the parts for building 88 production DFEA.  Labor BOE- n/a  M&S BOE - Cost based on per board prototype parts for the STC - \$200/board. See BOE binder.											
1.2.3.7.7	PCB Fabricate	6/15/04	7/27/04	\$0	\$775	\$0	\$775				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
8	ElecTechU	5%	\$0	\$0	\$0	\$0	12 h	0 h	0 h	0 h	12 h
15	MandS	775.2	\$775	\$0	\$0	\$775	775.2		0	0	775.2
<u>Notes</u> WBS Definition- PCB fabrication of the DFEA production board.  Labor BOE- Based on Run2a STC - includes collecting the files needed by the vendor for PCB fabrication.  M&S BOE - Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.											
1.2.3.7.8	PCB Fabricate	6/15/04	7/27/04	\$30,800	\$0	\$0	\$30,800				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	MandS	30,800	\$30,800	\$0	\$0	\$30,800	30,800		0	0	30,800
<u>Notes</u> WBS Definition- PCB fabrication of the DFEA production board.  Labor BOE- n/a  M&S BOE - Based on Run2a DFEA vendor quote - see BOE binder - \$350/board											
1.2.3.7.9	Assembly	7/28/04	8/24/04	\$0	\$352	\$0	\$352				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
8	ElecTechU	3%	\$0	\$0	\$0	\$0	4.8 h	0 h	0 h	0 h	4.8 h
15	MandS	351.95	\$352	\$0	\$0	\$352	351.95		0	0	351.95
<u>Notes</u> WBS Definition- Assembly of the DFEA production boards.  Labor BOE- Based on Run2a STC - includes collecting the parts needed by the vendor for PCB assembly.  M&S BOE - Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.											

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.3.7.10	Assembly	7/28/04	8/24/04	\$8,800	\$0	\$0	\$8,800
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	15 MandS 8,800 \$8,800 \$0 \$0 \$8,800 8,800 0 0 8,800						
	<i>Notes</i> WBS Definition- Assembly of the DFEA production boards.  Labor BOE- n/a  M&S BOE - Based on Run2a DFE vendor quote - see BOE binder - 100\$/board.						
1.2.3.7.11	Bench test	8/25/04	10/20/04	\$0	\$15,504	\$0	\$15,504
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 75% \$0 \$0 \$0 \$0 240 h 0 h 0 h 0 h 240 h						
	15 MandS 15,504 \$15,504 \$0 \$0 \$15,504 15,504 0 0 15,504						
	<i>Notes</i> WBS Definition- Test each production board on the test stand before intallation.  M&S BOE- Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.  Labor BOE- Test 10 boards a week. To be done by BU EDF engineer in conjunction with a physicist.						
1.2.3.7.12	Bench test	8/25/04	10/20/04	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 50% \$0 \$0 \$0 \$0 160 h 0 h 0 h 0 h 160 h						
	<i>Notes</i> WBS Definition- Test each production board on the test stand before intallation - done by physicist.  Labor BOE- Test 10 boards a week.						
1.2.3.7.13	Test at Fermilab	9/9/04	3/16/05	\$0	\$12,920	\$0	\$12,920
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 20% \$0 \$0 \$0 \$0 200 h 0 h 0 h 0 h 200 h						
	15 MandS 12,920 \$12,920 \$0 \$0 \$12,920 12,920 0 0 12,920						
	<i>Notes</i> WBS Definition- Re-test each board after delivery to Fermilab.  M&S BOE- Labor charges based on the BU EDF rate of \$40/hr and an overhead of 61.5%.  Labor BOE- Testing of the DFEA boards at Fermilab will be done using the modified Run2a DFEA infrastructure. This setup will be a collaboration between enginner at FNAL, technical person at FNAL, and a physicist who has been involved in the prototype testing. All of these personnel will have been trained on the prototype test phase. We expect to complete the entire test chain using the datapump and be able to test one board every day. This will allow 7 weeks for rework/retest of some of the boards if necessary.						
1.2.3.7.14	Test at Fermilab	9/9/04	3/16/05	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 100% \$0 \$0 \$0 \$0 1,000 h 0 h 0 h 0 h 1,000 h						
	<i>Notes</i> WBS Definition-						

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
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"Test at Fermilab" continued

Notes

Test production boards in special runs in the real Dzero trigger.

Labor BOE-

Done by physicist. Testing of the DFEA boards at Fermilab will be done using the modified Run2a DFEA infrastructure. This setup will be a collaboration between engineer at FNAL, technical person at FNAL, and a physicist who has been involved in the prototype testing. All of these personnel will have been trained on the prototype test phase. We expect to complete the entire test chain using the datapump and be able to test one board every day. This will allow 7 weeks for rework/retest of some of the boards if necessary.

1.2.3.7.15	Test at Fermilab	9/9/04	3/16/05	\$0	\$0	\$0	\$0
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ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	PhysicistU	100%	\$0	\$0	\$0	\$0	1,000 h	0 h	0 h	0 h	1,000 h

Notes

WBS Definition-

Test production boards in special runs in the real Dzero trigger.

Labor BOE-

Done by physicist. Testing of the DFEA boards at Fermilab will be done using the modified Run2a DFEA infrastructure. This setup will be a collaboration between enginner at FNAL, technical person at FNAL, and a physicist who has been involved in the prototype testing. all of these personnel will have been trained on the prototype test phase. We expect to complete the entire test chain using the datapump and be able to test one board every day. This will allow 7 weeks for rework/retest of some of the boards if necessary.

1.2.3.7.16	Test at Fermilab	9/9/04	3/16/05	\$0	\$36,750	\$0	\$36,750
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ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
8	ElecTechU	100%	\$0	\$0	\$0	\$0	1,000 h	0 h	0 h	0 h	1,000 h
10	PhysicistU	100%	\$0	\$0	\$0	\$0	1,000 h	0 h	0 h	0 h	1,000 h
15	MandS	36,750	\$36,750	\$0	\$0	\$36,750	36,750		0	0	36,750

Notes

WBS Definition-

Test production boards in special runs in the real Dzero trigger.

M&S BOE: 25 weeks of Norte Dame engineer at \$3609/wk (including 25% benefits and 48.5% indirect). = \$90,234

Labor BOE-

Done by physicist. Testing of the DFEA boards at Fermilab will be done using the modified Run2a DFEA infrastructure. This setup will be a collaboration between enginner at FNAL, technical person at FNAL, and a physicist who has been involved in the prototype testing. all of these personnel will have been trained on the prototype test phase. We expect to complete the entire test chain using the datapump and be able to test one board every day. This will allow 7 weeks for rework/retest of some of the boards if necessary.

1.2.3.7.17	Test at Fermilab	9/9/04	3/16/05	\$0	\$0	\$39,000	\$39,000
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ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
7	ElecTechF	100%	\$39,000	\$0	\$0	\$39,000	1,000 h	0 h	0 h	0 h	1,000 h
9	PhysicistF	50%	\$0	\$0	\$0	\$0	500 h	0 h	0 h	0 h	500 h

Notes

WBS Definition-

Test production boards in special runs in the real Dzero trigger.

Labor BOE-

Done by physicist. Testing of the DFEA boards at Fermilab will be done using the modified Run2a DFEA infrastructure. This setup will be a collaboration between enginner at FNAL, technical person at FNAL, and a physicist who has been involved in the prototype testing. all of these personnel will have been trained on the prototype test phase. We expect to complete the entire test chain using the datapump and be able to test one board every day. This will allow 7 weeks for rework/retest of some of the boards if necessary.

1.2.3.7.18	Board rework	9/9/04	3/16/05	\$8,800	\$0	\$0	\$8,800
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ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	PhysicistU	100%	\$0	\$0	\$0	\$0	1,000 h	0 h	0 h	0 h	1,000 h
15	MandS	8,800	\$8,800	\$0	\$0	\$8,800	8,800		0	0	8,800

Notes

WBS Definition-

Rework of FPGA assemblies on DFEA boards

M&S BOE-

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																								
"Board rework" continued																															
<div>Notes</div> Testing of the DFEA boards at Fermilab will be done using the modified Run2a DFEA infrastructure. We had several problems with FPGA contacts on the Run2a STC boards and this needed rework. This project will have 4 times more FPGAs on the board. Therefore we allocate an average \$100 per board for PFGA rework based on vendor quote for Run2a board rework. Quote in BOE binder.																															
1.2.3.7.19	L1 Central Track Trigger Production And Testing C	3/16/05	3/16/05	\$0	\$0	\$0	\$0																								
<div>Notes</div> WBS Definition-milestone: track trigger complete except for installation and commissioning																															
1.2.3.7.20	L1 Trigger Upgrade Production and Testing Compl	3/16/05	3/16/05	\$0	\$0	\$0	\$0																								
<div>Notes</div> WBS Definition-milestone: All Level 1 trigger upgrade systems produced and tested.																															
1.2.4	Level 2 Beta Processor	12/1/03	2/28/05	\$48,950	\$44,466	\$0	\$93,416																								
<div>Notes</div> WBS Definition-This summary element includes the procurement of additional single-board computers (Level 2 Beta processors), associated hardware, and firmware support.																															
1.2.4.1	Finalize Targets For Run2b Beta Upgrades	12/1/03	9/13/04	\$0	\$0	\$0	\$0																								
<div>Notes</div> WBS Definition-Find appropriate upgrade processor boards for L2Beta system and determine any necessary changes to the system to function wiht the new boards. This includes a study of software and firmware implications and also any hardware incompatibilities that may have to be addressed. The hardware issues would be limited to hard disk connections that differ between manufacturers.																															
1.2.4.1.1	Assess Performance of Run2a Betas	12/1/03	2/4/04	\$0	\$0	\$0	\$0																								
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>10</td><td>PhysicistU</td><td>25%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>80 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>80 h</td></tr></table> <div>Notes</div> WBS Definition-Evauate performance of L2Beta processors in Run2a. Determine areas of greatest need for increased processing power.  Labor BOE-Compile data on overall performance of L2Betas in Run2a. Rejection factors vs. Luminosity, efficiencies measured from data, etc. Estimate impact of Run2b luminosity and hardware upgrades on this performance.  M&S BOE-n/a								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	10	PhysicistU	25%	\$0	\$0	\$0	\$0	80 h	0 h	0 h	0 h	80 h
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																				
10	PhysicistU	25%	\$0	\$0	\$0	\$0	80 h	0 h	0 h	0 h	80 h																				
1.2.4.1.2	Assess Performance of Run2a Betas	12/1/03	2/4/04	\$0	\$0	\$0	\$0																								
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>10</td><td>PhysicistU</td><td>200%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>640 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>640 h</td></tr></table> <div>Notes</div> WBS Definition-Evauate performance of L2Beta processors in Run2a. Determine areas of greatest need for increased processing power.  Labor BOE-Compile data on overall performance of L2Betas in Run2a. Rejection factors vs. Luminosity, efficiencies measured from data, etc. Estimate impact of Run2b luminosity and hardware upgrades on this performance.  M&S BOE-n/a								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	10	PhysicistU	200%	\$0	\$0	\$0	\$0	640 h	0 h	0 h	0 h	640 h
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																				
10	PhysicistU	200%	\$0	\$0	\$0	\$0	640 h	0 h	0 h	0 h	640 h																				
1.2.4.1.3	Develop & Simulate New Run2b Algorithms	2/5/04	9/3/04	\$0	\$0	\$0	\$0																								
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>10</td><td>PhysicistU</td><td>100%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>1,200 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>1,200 h</td></tr></table>								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	10	PhysicistU	100%	\$0	\$0	\$0	\$0	1,200 h	0 h	0 h	0 h	1,200 h
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																				
10	PhysicistU	100%	\$0	\$0	\$0	\$0	1,200 h	0 h	0 h	0 h	1,200 h																				



WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost				
"Develop & Simulate New Run2b Algorithms" continued											
<div>Notes</div> <div>WBS Definition- Develop Run2b algorithms for the Beta processors.</div> <div>Labor BOE- With trigger simulations of upgraded L1 systems and L2STT, develop trigger algorithms necessary deliver necessary rejection at L2 for Run2b. Measure algorithm timing in simulator to determining CPU requirements for each L2 subsystem.</div> <div>M&amp;S BOE- n/a</div>											
1.2.4.1.4	Develop & Simulate New Run2b Algorithms	2/5/04	9/3/04	\$0	\$0	\$0	\$0				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	PhysicistU	100%	\$0	\$0	\$0	\$0	1,200 h	0 h	0 h	0 h	1,200 h
<div>Notes</div> <div>WBS Definition- Develop Run2b algorithms for the Beta processors.</div> <div>Labor BOE- With trigger simulations of upgraded L1 systems and L2STT, develop trigger algorithms necessary deliver necessary rejection at L2 for Run2b. Measure algorithm timing in simulator to determining CPU requirements for each L2 subsystem.</div> <div>M&amp;S BOE- n/a</div>											
1.2.4.1.5	Develop & Simulate New Run2b Algorithms	2/5/04	9/3/04	\$0	\$0	\$0	\$0				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	PhysicistU	400%	\$0	\$0	\$0	\$0	4,800 h	0 h	0 h	0 h	4,800 h
<div>Notes</div> <div>WBS Definition- Develop Run2b algorithms for the Beta processors.</div> <div>Labor BOE- With trigger simulations of upgraded L1 systems and L2STT, develop trigger algorithms necessary deliver necessary rejection at L2 for Run2b. Measure algorithm timing in simulator to determining CPU requirements for each L2 subsystem.</div> <div>M&amp;S BOE- n/a</div>											
1.2.4.1.6	Production readiness review	9/7/04	9/13/04	\$0	\$0	\$0	\$0				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	PhysicistU	200%	\$0	\$0	\$0	\$0	80 h	0 h	0 h	0 h	80 h
<div>Notes</div> <div>WBS Definition- All components needed to test the prototype Beta are acquired and working.</div>											
1.2.4.2	Develop Prototype	3/18/04	8/6/04	\$8,610	\$24,123	\$0	\$32,733				
<div>Notes</div> <div>WBS Definition- Find appropriate upgrade processor boards for L2Beta system and determine any necessary changes to the system to function wiht the new boards. This includes a study of software and firmware implications and also any hardware incompatibilities that may have to be addressed. The hardware issues would be limited to hard disk connections that differ between manufacturers.</div>											
1.2.4.2.1	Survey processor market, chose candidate SBCs	3/18/04	4/14/04	\$0	\$0	\$0	\$0				
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	PhysicistU	25%	\$0	\$0	\$0	\$0	40 h	0 h	0 h	0 h	40 h
<div>Notes</div> <div>WBS Definition-</div>											

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost				
"Survey processor market, chose candidate SBCs" continued											
<u>Notes</u> Start search for upgraded processors. Compare cPCI processors on market for compaitibility and performance in L2Beta motherboards.											
Labor BOE- Experience w/ original Beta processors. Survey cPCI board manufactures, request literature and price quotes, and compare specifications of boards.											
M&S BOE- n/a											
1.2.4.2.2	Evaluate software impact of new SBCs	3/18/04	4/14/04	\$0	\$0	\$0	\$0				
<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
10	PhysicistU	25%	\$0	\$0	\$0	\$0	40 h	0 h	0 h	0 h	40 h
<u>Notes</u> WBS Definition- Determine if newer boards require changes to existing code.											
Labor BOE- Experience w/ design/development of hardware driver code for Run2a Alpha and Beta processors.											
M&S BOE- n/a											
1.2.4.2.3	Evaluate firmware impact of new SBCs (function)	3/18/04	4/14/04	\$0	\$0	\$0	\$0				
<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
10	PhysicistU	25%	\$0	\$0	\$0	\$0	40 h	0 h	0 h	0 h	40 h
<u>Notes</u> WBS Definition- Determine extent of any necessary firmware changes to use new board and/or upgrade system performance. The only changes forseen are limited to interrupt generation firmware.											
Labor BOE- This task is equivalent to a small module included in the Run2a Beta firmware. Most of the technical issues should be uncovered in the market survey. Any proposed changes would then be disscussed with all L2 software experts.											
M&S BOE- Experience w/ original Beta processors. This task is equivalent to a small module included in the Run2a Beta firmware.											
1.2.4.2.4	Evaluate firmware impact of new SBCs (coding)	3/18/04	4/14/04	\$0	\$8,247	\$0	\$8,247				
<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
4	ElecEngU	50%	\$0	\$0	\$0	\$0	80 h	0 h	0 h	0 h	80 h
15	MandS	8,247.2	\$8,247	\$0	\$0	\$8,247	8,247.2	0	0	0	8,247.2
<u>Notes</u> WBS Definition- Determine extent of any necessary firmware changes to use new board and/or upgrade system performance. The only changes forseen are limited to interrupt generation firmware.											
Labor BOE- In the Run2a beta project we typically have had 1 week turnaround on firmware changes involving protocol changes between our 9U board and the SBC. A recent project of similar scale involved changing of output buffering in internal FIFOs of our FPGA and completion simulation studies. New interrupt logic would require full simulation in order to check interactions with our internal state machines. Our project allows time for studies of two designs.											
M&S BOE- Experience w/ original Beta processors. This task is equivalent to a small module included in the Run2a Beta firmware.											
1.2.4.2.5	Acquire 2 new processor SBCs for evaluation	4/15/04	7/9/04	\$8,160	\$0	\$0	\$8,160				
<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
10	PhysicistU	5%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h
15	MandS	8,160	\$8,160	\$0	\$0	\$8,160	8,160	0	0	0	8,160
<u>Notes</u> WBS Definition-											

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost					
"Acquire 2 new processor SBCs for evaluation" continued												
<u>Notes</u> Acquire cPCI boards for software/firmware tests of upraded L2Beta system.												
Labor BOE- Experience w/ original Beta processors. Order lead times varied among manufacturers from 2-12 weeks.												
M&S BOE- Estimated from vendor quotes (prices range 30% across manufacturers due to differences in both base prices and available configurations). Quotes from Advantec and VMIC are included inthe project documentation.												
1.2.4.2.6	Design Disk adapter	4/15/04	5/12/04	\$0	\$4,124	\$0	\$4,124					
	<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
	4	ElecEngU	25%	\$0	\$0	\$0	\$0	40 h	0 h	0 h	0 h	40 h
	15	MandS	4,123.6	\$4,124	\$0	\$0	\$4,124	4,123.6		0	0	4,123.6
<u>Notes</u> WBS Definition- cPCI manufacturers have no uniform standards for i/o pins, not specified by the cPCI specification. The new SBC choosen for the Betas may require a small passive adapter card to attach to the hard drive.												
Labor BOE- Space and Mechanical constraints must be addressed for the adapter design. Similar issues were addresses in the design of the 9U motherboard for the Run2a Beta project. Contingency estimate based on guidance for tasks w/o existing conceptual design.												
M&S BOE- n/a												
1.2.4.2.7	Specify/Acquire adapter components	5/13/04	6/10/04	\$200	\$825	\$0	\$1,025					
	<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
	4	ElecEngU	5%	\$0	\$0	\$0	\$0	8 h	0 h	0 h	0 h	8 h
	15	MandS	1,024.72	\$1,025	\$0	\$0	\$1,025	1,024.72		0	0	1,024.72
<u>Notes</u> WBS Definition- Choose and purchase components for disk adapters: hard metric connectors, headers, cables.												
Labor BOE- Labor is limited to placing 1-2 online of telephone orders.												
M&S BOE- Catalog pricing for connectors, cables. See catalog pricing from Newark in attached documentation for cost of major components. 12 boards + 10% spare parts ~ \$200. Contingency based on guidance for quotations.												
1.2.4.2.8	Layout adapter, generate artwork, etc	6/11/04	6/24/04	\$0	\$8,247	\$0	\$8,247					
	<i>ID</i>	<i>Resource Name</i>	<i>Units</i>	<i>Cost</i>	<i>Baseline Cost</i>	<i>Act. Cost</i>	<i>Rem. Cost</i>	<i>Work</i>	<i>Ovt. Work</i>	<i>Baseline Work</i>	<i>Act. Work</i>	<i>Rem. Work</i>
	4	ElecEngU	100%	\$0	\$0	\$0	\$0	80 h	0 h	0 h	0 h	80 h
	15	MandS	8,247.2	\$8,247	\$0	\$0	\$8,247	8,247.2		0	0	8,247.2
<u>Notes</u> WBS Definition- Generate artwork for the disk adapter.												
Labor BOE- The disk adapter design requires a small (~3inch by 1 inch) pcb w/ a hard metric connector, a 40pin header and 40 traces routed. The board would be passive and include 2 or 4 signal layers. Space and Mechanical constraints must be addressed for the adapter design. The estimate is base on 3 days electrical design and mechanical design. 2 days in house mechanical prototyping. 1 day layout. 1 day finalize artwork and review. (Layout Engineers + EE + Mech. staff may all be involved). Contingency estimate based on guidance for tasks w/o existing conceptual design.												
M&S BOE- n/a												

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.4.2.9	Find manufacturer for disk adapters	6/25/04	7/9/04	\$0	\$2,062	\$0	\$2,062
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 25% \$0 \$0 \$0 \$0 20 h 0 h 0 h 0 h 20 h						
	15 MandS 2,061.8 \$2,062 \$0 \$0 \$2,062 2,061.8 0 0 2,061.8						
	<u>Notes</u>						
	WBS Definition- Find a manufacturer for the disk adapters.						
	Labor BOE- Contracting the production of a small 2 to 4 layer PCB from a local manufacturer. 1 day for collecting quotes + 1.5 day for internal paperwork, transmitting artwork, etc.						
	M&S BOE- n/a						
1.2.4.2.10	Produce prototype adapters	7/12/04	7/30/04	\$250	\$619	\$0	\$869
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 5% \$0 \$0 \$0 \$0 6 h 0 h 0 h 0 h 6 h						
	15 MandS 868.54 \$869 \$0 \$0 \$869 868.54 0 0 868.54						
	<u>Notes</u>						
	WBS Definition- Produce 2 prototype disk adapters						
	Labor BOE- Labor is limited to coordinating manufacture w/ PCB company. Checking on production status, visual inspection of boards.						
	M&S BOE- Based of Quotes from online survey (Included in attached documentation for PCB Express); 2 boards less than 9 square inches = \$250						
1.2.4.2.11	Test prototype adapters	8/2/04	8/6/04	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 25% \$0 \$0 \$0 \$0 10 h 0 h 0 h 0 h 10 h						
	<u>Notes</u>						
	WBS Definition- Test prototype disk adapters.						
	Labor BOE- Based on experience with Run2a Beta boards. Plug it in and see if it works! If not check connections (again), repair and repeat.						
	M&S BOE- n/a						
1.2.4.2.12	Level 2 Beta Trigger Prototype Preparation Complete	8/6/04	8/6/04	\$0	\$0	\$0	\$0
	<u>Notes</u>						
	WBS Definition- milestone: All components needed to test the prototype Beta are acquired and working.						
1.2.4.3	Test Prototype	8/9/04	11/1/04	\$0	\$19,793	\$0	\$19,793
	<u>Notes</u>						
	WBS Definition- Verify operation of cPCI boards with L2Beta 9U motherboards.						
1.2.4.3.1	Verify software compatibility / hardware interface patch	8/9/04	10/4/04	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 30% \$0 \$0 \$0 \$0 96 h 0 h 0 h 0 h 96 h						
	<u>Notes</u>						
	WBS Definition- Verify software and mother card functions w/ new SBC.						

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Verify software compatiibity / hardware interface patches" continued							
<div>Notes</div> Labor BOE- Experience w/ original Beta processors - make any necessary chnages to compile code on new boards or to access new registers.  M&S BOE- n/a							
1.2.4.3.2	Firmware support and tuning	8/9/04	10/4/04	\$0	\$19,793	\$0	\$19,793
	<div><div>IDResource NameUnitsCostBaseline CostAct. CostRem. CostWorkOvt. WorkBaseline WorkAct. WorkRem. Work</div><div>4ElecEngU60%\$0\$0\$0\$0192 h0 h0 h0 h192 h</div><div>15MandS19,793.28\$19,793\$0\$0\$19,79319,793.280019,793.28</div></div>						
<div>Notes</div> WBS Definition- Develop any necessary (or desired) firmware enhancments.  Labor BOE- We allot time for approximately 4 moderate firmware changes with full simulation stuties. (1 week each, same as estimate in 1.2.4.2.4)  M&S BOE- n/a							
1.2.4.3.3	Verify processor operability in Beta motherboards	8/9/04	10/4/04	\$0	\$0	\$0	\$0
	<div><div>IDResource NameUnitsCostBaseline CostAct. CostRem. CostWorkOvt. WorkBaseline WorkAct. WorkRem. Work</div><div>10PhysicistU60%\$0\$0\$0\$0192 h0 h0 h0 h192 h</div></div>						
<div>Notes</div> WBS Definition- Test an assembled card under typical I/O conditions.  Labor BOE- Estimate from experience with Run2a Betas.  M&S BOE- n/a							
1.2.4.3.4	Shadow mode studies	10/5/04	11/1/04	\$0	\$0	\$0	\$0
<div>Notes</div> WBS Definition- Time reserved for additional prototype studies and algorithm tests in 'shadow' mode while experiment is running.							
1.2.4.3.5	Level 2 Beta Trigger Prototype Testing Complete	11/1/04	11/1/04	\$0	\$0	\$0	\$0
<div>Notes</div> WBS Definition- milestone: The prototype Beta meets functional i/o requirements.							
1.2.4.4	Assemble Production Processors	10/5/04	2/28/05	\$40,340	\$550	\$0	\$40,890
<div>Notes</div> WBS Definition- Assemble Production Processors							
1.2.4.4.1	Produce Disk Adapters	10/5/04	10/25/04	\$500	\$550	\$0	\$1,050
	<div><div>IDResource NameUnitsCostBaseline CostAct. CostRem. CostWorkOvt. WorkBaseline WorkAct. WorkRem. Work</div><div>8ElecTechU10%\$0\$0\$0\$012 h0 h0 h0 h12 h</div><div>15MandS1,050\$1,050\$0\$0\$1,0501,050001,050</div></div>						
<div>Notes</div> WBS Definition- Produce anapters for SBC hard drive connectors							

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost				
"Produce Disk Adapters" continued											
<u>Notes</u> Labor BOE- Technican's time to coordinate production w/ manufacturer  M&S BOE- Based of Quotes from online survey (Included in attached documentation for PCB Express) 35 boards less than 9 square inches ~ \$500 based on 20 board estimate(\$375) + marginal cost/board of 8.75 for larger production (\$375-\$250(setup))/20. Extra PCBs over the 12 needed are inexpensive and will cover the contingency of needing to install more fast CPUs.											
1.2.4.4.2	Finalize Run2b SBC order	11/2/04	11/15/04	\$0	\$0	\$0	\$0				
<u>ID</u>	<u>Resource Name</u>	<u>Units</u>	<u>Cost</u>	<u>Baseline Cost</u>	<u>Act. Cost</u>	<u>Rem. Cost</u>	<u>Work</u>	<u>Ovt. Work</u>	<u>Baseline Work</u>	<u>Act. Work</u>	<u>Rem. Work</u>
10	PhysicistU	30%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h
<u>Notes</u> WBS Definition- Finialize order details for cPCI boards for upgrade of system.  M&S BOE- n/a  Labor BOE- Experience w/ original Beta processors. Allow 2 weeks to get final quotes, possible quantity discounts, and to generate POs.											
1.2.4.4.3	Acquire Run2b SBCs	11/16/04	2/21/05	\$39,840	\$0	\$0	\$39,840				
<u>ID</u>	<u>Resource Name</u>	<u>Units</u>	<u>Cost</u>	<u>Baseline Cost</u>	<u>Act. Cost</u>	<u>Rem. Cost</u>	<u>Work</u>	<u>Ovt. Work</u>	<u>Baseline Work</u>	<u>Act. Work</u>	<u>Rem. Work</u>
10	PhysicistU	5%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h
15	MandS	39,840	\$39,840	\$0	\$0	\$39,840	39,840		0	0	39,840
<u>Notes</u> WBS Definition- Procure full complement of SBC cards.  M&S BOE- (Prices range 30% across manufacturers.) Based of Quotes from Advantech and VMIC (Included in attached documentation.)  Labor BOE- Experience w/ original Beta processors. Manufactures lead times vary from 2-12 weeks, depending on stock in hand.  Rick Mitigation- Cost: Contingency is included for the purchase of 24 boards instead of 12. The base plan is to upgrade the only the most heavily loaded processors in Run2b. In the event that CPU demands across the system are greater than expected, 24 boards allow for the upgrade of ALL worker nodes in the system. A contingency of 130% is included: 100% for purchase of nodes + 30% for price CPU ranges as noted in the M&S BOE.											
1.2.4.4.5	Test production disk adapters	10/26/04	11/1/04	\$0	\$0	\$0	\$0				
<u>ID</u>	<u>Resource Name</u>	<u>Units</u>	<u>Cost</u>	<u>Baseline Cost</u>	<u>Act. Cost</u>	<u>Rem. Cost</u>	<u>Work</u>	<u>Ovt. Work</u>	<u>Baseline Work</u>	<u>Act. Work</u>	<u>Rem. Work</u>
10	PhysicistU	25%	\$0	\$0	\$0	\$0	10 h	0 h	0 h	0 h	10 h
<u>Notes</u> WBS Definition- Test production disk drive adapters.  Labor BOE- Cycle through all adapters on test stand to very disk access works.  M&S BOE- n/a											
1.2.4.4.4	Test SBCs	2/22/05	2/28/05	\$0	\$0	\$0	\$0				
<u>ID</u>	<u>Resource Name</u>	<u>Units</u>	<u>Cost</u>	<u>Baseline Cost</u>	<u>Act. Cost</u>	<u>Rem. Cost</u>	<u>Work</u>	<u>Ovt. Work</u>	<u>Baseline Work</u>	<u>Act. Work</u>	<u>Rem. Work</u>
10	PhysicistU	25%	\$0	\$0	\$0	\$0	10 h	0 h	0 h	0 h	10 h

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																																																	
"Test SBCs" continued																																																																								
	<div>Notes</div> WBS Definition- Test SBC boards, retrain any defective boards for warranty repair/replacement.  Labor BOE- Experience w/ original Beta processors - plug in all boards at test crate. Return any DOA boards.  M&S BOE- n/a																																																																							
1.2.4.4.6	L2 Beta Trigger Production And Testing Complete	2/28/05	2/28/05	\$0	\$0	\$0	\$0																																																																	
	<div>Notes</div> WBS Definition- milestone: All parts for upgrade Level 2 Betas in hand and working.																																																																							
1.2.5	Silicon Track Trigger Upgrade	12/2/02	2/28/05	\$172,235	\$58,852	\$3,463	\$234,550																																																																	
	<div>Notes</div> WBS Definition- This summary element includes upgrades to the Run 2a silicon track trigger to adapt it to the increased number of inputs from the Run 2b silicon detector. It consists of the procurement of additional electronics boards of the Run 2a type. Also included are firmware changes, and additional cabling and connector hardware.																																																																							
1.2.5.1	Place Parts Orders for L2 Silicon Track Trigger	4/1/03	4/1/03	\$0	\$0	\$0	\$0																																																																	
	<div>Notes</div> WBS Definition- milestone:																																																																							
1.2.5.20	Production Readiness Review	7/26/04	7/30/04	\$0	\$1,292	\$0	\$1,292																																																																	
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>50%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>20 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>20 h</td></tr><tr><td>9</td><td>PhysicistF</td><td>20%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>8 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>8 h</td></tr><tr><td>10</td><td>PhysicistU</td><td>100%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>40 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>40 h</td></tr><tr><td>15</td><td>MandS</td><td>1,292</td><td>\$1,292</td><td>\$0</td><td>\$0</td><td>\$1,292</td><td>1,292</td><td></td><td>0</td><td>0</td><td>1,292</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	50%	\$0	\$0	\$0	\$0	20 h	0 h	0 h	0 h	20 h	9	PhysicistF	20%	\$0	\$0	\$0	\$0	8 h	0 h	0 h	0 h	8 h	10	PhysicistU	100%	\$0	\$0	\$0	\$0	40 h	0 h	0 h	0 h	40 h	15	MandS	1,292	\$1,292	\$0	\$0	\$1,292	1,292		0	0	1,292											
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																													
4	ElecEngU	50%	\$0	\$0	\$0	\$0	20 h	0 h	0 h	0 h	20 h																																																													
9	PhysicistF	20%	\$0	\$0	\$0	\$0	8 h	0 h	0 h	0 h	8 h																																																													
10	PhysicistU	100%	\$0	\$0	\$0	\$0	40 h	0 h	0 h	0 h	40 h																																																													
15	MandS	1,292	\$1,292	\$0	\$0	\$1,292	1,292		0	0	1,292																																																													
	<div>Notes</div> WBS Definition- Review and sign-off for PCB production.																																																																							
1.2.5.2	Begin L2 Silicon Track Trigger Run IIb PCB Produc	8/2/04	8/2/04	\$0	\$0	\$0	\$0																																																																	
	<div>Notes</div> WBS Definition- milestone: beginRun IIb PCB production.																																																																							
1.2.5.3	L2 Silicon Track Trigger Run IIb Inputs Finalized	9/2/03	9/2/03	\$0	\$0	\$0	\$0																																																																	
	<div>Notes</div> WBS Definition- milestone - Format of inputs from upgraded L1CTT and new SMT are fixed.																																																																							
1.2.5.4	VME Motherboard	4/1/03	11/22/04	\$35,991	\$2,880	\$0	\$38,871																																																																	
	<div>Notes</div> WBS Definition- Common 9Ux400 mm VME motherboard for all STT modules. Design is the same as for Run 2a. 20 boards needed.																																																																							
1.2.5.4.1	Place orders	4/1/03	4/3/03	\$0	\$480	\$0	\$480																																																																	
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>8</td><td>ElecTechU</td><td>100%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>24 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>24 h</td></tr><tr><td>15</td><td>MandS</td><td>480</td><td>\$480</td><td>\$0</td><td>\$0</td><td>\$480</td><td>480</td><td></td><td>0</td><td>0</td><td>480</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	8	ElecTechU	100%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h	15	MandS	480	\$480	\$0	\$0	\$480	480		0	0	480																																			
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																																													
8	ElecTechU	100%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h																																																													
15	MandS	480	\$480	\$0	\$0	\$480	480		0	0	480																																																													
	<div>Notes</div> WBS Definition-																																																																							

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Place orders" continued							
<u>Notes</u> Get quotes, place orders, ship parts, etc.							
M&S Labor BoE- 24 hours @ \$20/hour for technician based on Run 2a experience for same boards.							
1.2.5.4.2	Parts	4/4/03	5/30/03	\$13,591	\$0	\$0	\$13,591
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	15 MandS 13,591 \$13,591 \$0 \$0 \$13,591 13,591 0 0 13,591						
<u>Notes</u> WBS Definition- Procure parts for motherboards.							
M&S BOE- POs from Run 2a purchase, adjusted for smaller quantities (see mb cost spreadsheet of Run 2a purchases.)							
1.2.5.4.3	Fabricate PCB	8/2/04	8/27/04	\$7,800	\$0	\$0	\$7,800
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	15 MandS 7,800 \$7,800 \$0 \$0 \$7,800 7,800 0 0 7,800						
<u>Notes</u> WBS Definition Fabrication of PC boards for motherboards by outside vendor.							
M&S BoE Quote from Cirexx.							
1.2.5.4.4	Assemble	8/30/04	9/27/04	\$14,600	\$0	\$0	\$14,600
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	15 MandS 14,600 \$14,600 \$0 \$0 \$14,600 14,600 0 0 14,600						
<u>Notes</u> WBS Definition Assembly of motherboards by outside vendor.							
M&S BOE- e-mail from Whitman: 20 boards @ \$700/board + \$600 NRE = \$14,600							
1.2.5.4.5	All L2 Silicon Track Trigger Motherboards Delivere	9/27/04	9/27/04	\$0	\$0	\$0	\$0
<u>Notes</u> WBS Definition- milestone: All 20 motherboards have been received from assembly house.							
1.2.5.4.6	Test	9/28/04	11/22/04	\$0	\$2,400	\$0	\$2,400
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 10% \$0 \$0 \$0 \$0 32 h 0 h 0 h 0 h 32 h						
	8 ElecTechU 20% \$0 \$0 \$0 \$0 64 h 0 h 0 h 0 h 64 h						
	15 MandS 2,400 \$2,400 \$0 \$0 \$2,400 2,400 0 0 2,400						
<u>Notes</u> WBS Definition- Test all functions of motherboards in test crate, fix problems as needed.							
M&S Labor BOE- per board for 20 boards: 1 hour @ \$40/h for electrical engineer 4 hours @ \$20/hour for technician Based on Run 2A experience with same boards.							



WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																				
1.2.5.4.8	L2 Silicon Track Trigger Motherboard Production (	11/22/04	11/22/04	\$0	\$0	\$0	\$0																																				
<div>Notes</div> WBS Definition- milestone: All motherboards have been tested for basic functionality and are ready to be installed at Fermilab.																																											
1.2.5.5	STC Module	4/1/03	11/22/04	\$21,058	\$1,600	\$0	\$22,658																																				
<div>Notes</div> WBS Definition- Daughter board that processes raw data from SMT. Design is the same as for Run 2a; 7 boards needed.																																											
1.2.5.5.1	Place orders	4/1/03	4/3/03	\$0	\$480	\$0	\$480																																				
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>8</td><td>ElecTechU</td><td>100%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>24 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>24 h</td></tr><tr><td>15</td><td>MandS</td><td>480</td><td>\$480</td><td>\$0</td><td>\$0</td><td>\$480</td><td>480</td><td></td><td>0</td><td>0</td><td>480</td></tr></table> <div>Notes</div> WBS definition- Get quotes, place orders, ship parts, etc.  M&S Labor BoE- 24 hours @ \$20/hour for technician based on Run 2a experience with same boards.								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	8	ElecTechU	100%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h	15	MandS	480	\$480	\$0	\$0	\$480	480		0	0	480
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
8	ElecTechU	100%	\$0	\$0	\$0	\$0	24 h	0 h	0 h	0 h	24 h																																
15	MandS	480	\$480	\$0	\$0	\$480	480		0	0	480																																
1.2.5.5.2	Parts	4/4/03	5/30/03	\$15,786	\$0	\$0	\$15,786																																				
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>15</td><td>MandS</td><td>15,786</td><td>\$15,786</td><td>\$0</td><td>\$0</td><td>\$15,786</td><td>15,786</td><td></td><td>0</td><td>0</td><td>15,786</td></tr></table> <div>Notes</div> WBS Definition- Procure parts for STCs.  M&S BOE POs of Run 2a purchases adjusted for smaller quantities (see STC cost spreadsheet from Run 2a purchases) and quote from Insight Electronics for Xilinx FPGAs.								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	15	MandS	15,786	\$15,786	\$0	\$0	\$15,786	15,786		0	0	15,786												
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
15	MandS	15,786	\$15,786	\$0	\$0	\$15,786	15,786		0	0	15,786																																
1.2.5.5.3	Fabricate PCB	8/2/04	8/27/04	\$4,182	\$0	\$0	\$4,182																																				
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>15</td><td>MandS</td><td>4,182</td><td>\$4,182</td><td>\$0</td><td>\$0</td><td>\$4,182</td><td>4,182</td><td></td><td>0</td><td>0</td><td>4,182</td></tr></table> <div>Notes</div> WBS Definition- Fabrication of PC boards for STCs by outside vendor.  M&S BOE Quote from Cirexx.								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	15	MandS	4,182	\$4,182	\$0	\$0	\$4,182	4,182		0	0	4,182												
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
15	MandS	4,182	\$4,182	\$0	\$0	\$4,182	4,182		0	0	4,182																																
1.2.5.5.4	Assemble	8/30/04	9/27/04	\$1,090	\$0	\$0	\$1,090																																				
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>15</td><td>MandS</td><td>1,090</td><td>\$1,090</td><td>\$0</td><td>\$0</td><td>\$1,090</td><td>1,090</td><td></td><td>0</td><td>0</td><td>1,090</td></tr></table> <div>Notes</div> WBS Definition- Assembly of STC boards by outside vendor.  M&S BOE Quote by EMA for 70 STC + NRE (per board cost doubled to adjust for smaller quantity) 7 boards * \$70/board + \$600 NRE = \$1090.								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	15	MandS	1,090	\$1,090	\$0	\$0	\$1,090	1,090		0	0	1,090												
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
15	MandS	1,090	\$1,090	\$0	\$0	\$1,090	1,090		0	0	1,090																																
1.2.5.5.5	All L2 Silicon Track Trigger STCs Delivered	9/27/04	9/27/04	\$0	\$0	\$0	\$0																																				
<div>Notes</div> WBS Definition- milestone: all STCs have been received from assembly house																																											

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.5.5.6	Test	9/28/04	11/22/04	\$0	\$1,120	\$0	\$1,120
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 4% \$0 \$0 \$0 \$0 12.8 h 0 h 0 h 0 h 12.8 h						
	8 ElecTechU 8% \$0 \$0 \$0 \$0 25.6 h 0 h 0 h 0 h 25.6 h						
	15 MandS 1,120 \$1,120 \$0 \$0 \$1,120 1,120 0 0 1,120						
	<i>Notes</i> WBS Definition- Test all functions of STCs in test crate, fix problems as needed.  M&S Labor BOE- per board for 7 boards: 2 hours @ \$40/h for electrical engineer 4 hours @ \$20/h for technician based on Run 2a experience with same boards						
1.2.5.5.8	L2 Silicon Track Trigger STC Production Complete	11/22/04	11/22/04	\$0	\$0	\$0	\$0
	<i>Notes</i> WBS Definition- milestone: All STCs have been tested for functionality and are ready to be installed at Fermilab						
1.2.5.6	VTM	12/2/02	8/5/03	\$23,510	\$0	\$1,279	\$24,789
	<i>Notes</i> WBS Definition- VME Transition module with four Finisar optical receivers and HP g-link serial - parallel converters. Used to receive data from silicon detector front ends. Parts are becoming obsolete - need 6 more boards + 4 spares.  Risk Mitigation: The VME transition module has four Finisar optical receivers and HP g-link serial-to-parallel converters. Some parts used on this board (among them the Finisar receivers) are about to become obsolete. This board was difficult to design and the redesign required if different parts have to be used could mean significant engineering costs. To minimize this risk we intend to purchase the six boards required for the Run 2B upgrade plus 4 spares as soon as possible.						
1.2.5.6.1	Place order	12/2/02	12/3/02	\$0	\$0	\$468	\$468
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	7 ElecTechF 100% \$468 \$0 \$0 \$468 12 h 0 h 0 h 0 h 12 h						
	<i>Notes</i> WBS Definition- Get quotes, place order.  Labor BoE- 12 hours for a Fermilab technician						
1.2.5.6.2	Production	12/3/02	5/2/03	\$23,510	\$0	\$0	\$23,510
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	15 MandS 23,510 \$23,510 \$0 \$0 \$23,510 23,510 0 0 23,510						
	<i>Notes</i> WBS Definition- Procurement of parts, fabrication of PCB and assembly by outside vendor  M&S BOE- Cost of VTM purchased from Circuit Service for Run 2a STT (\$2351/VTM + 50% contingency).						
1.2.5.6.3	Test	5/2/03	8/5/03	\$0	\$0	\$811	\$811
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	7 ElecTechF 4% \$811 \$0 \$0 \$811 20.8 h 0 h 0 h 0 h 20.8 h						
	<i>Notes</i> WBS Definition- Test VTMs						

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																								
"Test" continued																																															
	<div>Notes</div> Labor BoE- 20 h of Fermilab Electronics Technician																																														
1.2.5.6.5	VTM Production Complete for L2 Silicon Track Triç	8/5/03	8/5/03	\$0	\$0	\$0	\$0																																								
	<div>Notes</div> WBS Definition- milestone: VTMs tested and ready for installation at D0																																														
1.2.5.7	Link Transmitter Board	4/1/03	11/8/04	\$9,469	\$1,280	\$0	\$10,749																																								
	<div>Notes</div> WBS Definition- PC-MIP board with three serial link transmitters for intermodule data transfer. Design is the same as for Run 2a. We need 52 boards.																																														
1.2.5.7.1	Place orders	4/1/03	4/2/03	\$0	\$240	\$0	\$240																																								
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>8</td><td>ElecTechU</td><td>100%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>12 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>12 h</td></tr><tr><td>15</td><td>MandS</td><td>240</td><td>\$240</td><td>\$0</td><td>\$0</td><td>\$240</td><td>240</td><td></td><td>0</td><td>0</td><td>240</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	8	ElecTechU	100%	\$0	\$0	\$0	\$0	12 h	0 h	0 h	0 h	12 h	15	MandS	240	\$240	\$0	\$0	\$240	240		0	0	240										
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																				
8	ElecTechU	100%	\$0	\$0	\$0	\$0	12 h	0 h	0 h	0 h	12 h																																				
15	MandS	240	\$240	\$0	\$0	\$240	240		0	0	240																																				
	<div>Notes</div> WBS definition- Get quotes, place orders, ship parts, etc  M&S Labor BoE- 12 hours @ \$20/hour for technician (shared with LRB place order task) based on Run 2a experience with same boards.																																														
1.2.5.7.2	Parts	4/2/03	5/29/03	\$6,561	\$0	\$0	\$6,561																																								
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>15</td><td>MandS</td><td>6,561</td><td>\$6,561</td><td>\$0</td><td>\$0</td><td>\$6,561</td><td>6,561</td><td></td><td>0</td><td>0</td><td>6,561</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	15	MandS	6,561	\$6,561	\$0	\$0	\$6,561	6,561		0	0	6,561																						
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																				
15	MandS	6,561	\$6,561	\$0	\$0	\$6,561	6,561		0	0	6,561																																				
	<div>Notes</div> WBS Definition- Procure parts for LTBs  M&S BOE POs from Run 2a purchases adjusted for smaller quantities (see LRB/LTB cost spreadsheet from Run 2a purchases)																																														
1.2.5.7.3	Fabricate PCB	8/2/04	8/27/04	\$2,190	\$0	\$0	\$2,190																																								
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>15</td><td>MandS</td><td>2,190</td><td>\$2,190</td><td>\$0</td><td>\$0</td><td>\$2,190</td><td>2,190</td><td></td><td>0</td><td>0</td><td>2,190</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	15	MandS	2,190	\$2,190	\$0	\$0	\$2,190	2,190		0	0	2,190																						
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																				
15	MandS	2,190	\$2,190	\$0	\$0	\$2,190	2,190		0	0	2,190																																				
	<div>Notes</div> WBS Definition- Fabrication of LTB PC boards by outside vendor  M&S BoE Quote from Cirexx for 330 boards + NRE (double per board cost to adjust for smaller quantity) 52 boards * \$30 + \$180 (NRE) + \$450 (NRE) = \$2190																																														
1.2.5.7.4	Assemble	8/30/04	9/27/04	\$718	\$0	\$0	\$718																																								
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>15</td><td>MandS</td><td>718</td><td>\$718</td><td>\$0</td><td>\$0</td><td>\$718</td><td>718</td><td></td><td>0</td><td>0</td><td>718</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	15	MandS	718	\$718	\$0	\$0	\$718	718		0	0	718																						
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																				
15	MandS	718	\$718	\$0	\$0	\$718	718		0	0	718																																				
	<div>Notes</div> WBS Definition- Assembly of LTB boards by outside vendor  M&S BOE Quote from EMA for 330 boards. They will give us the same price for smaller quantity of boards. Amount quoted includes NRE costs. 52 boards * \$9 + \$250 (NRE) = \$718																																														

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																				
1.2.5.7.5	All L2 Silicon Track Trigger LTBs Delivered	9/27/04	9/27/04	\$0	\$0	\$0	\$0																																				
<div>Notes</div> <div>WBS Definition- milestone: All LTBs have been received from the assembly house.</div>																																											
1.2.5.7.6	Test	9/28/04	11/8/04	\$0	\$1,040	\$0	\$1,040																																				
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>8</td><td>ElecTechU</td><td>33%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>79.2 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>79.2 h</td></tr><tr><td>15</td><td>MandS</td><td>1,040</td><td>\$1,040</td><td>\$0</td><td>\$0</td><td>\$1,040</td><td>1,040</td><td></td><td>0</td><td>0</td><td>1,040</td></tr></table> <div>Notes</div> <div>WBS Definition- Test all functions of LTBs in test PC, fix problems as needed.</div> <div>Labor BOE- 1 hour @ \$20/h for technician per board for 52 boards based on Run 2A experience with same boards.</div>								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	8	ElecTechU	33%	\$0	\$0	\$0	\$0	79.2 h	0 h	0 h	0 h	79.2 h	15	MandS	1,040	\$1,040	\$0	\$0	\$1,040	1,040		0	0	1,040
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
8	ElecTechU	33%	\$0	\$0	\$0	\$0	79.2 h	0 h	0 h	0 h	79.2 h																																
15	MandS	1,040	\$1,040	\$0	\$0	\$1,040	1,040		0	0	1,040																																
1.2.5.7.8	L2 Silicon Track Trigger LTB Production Complete	11/8/04	11/8/04	\$0	\$0	\$0	\$0																																				
<div>Notes</div> <div>WBS Definition- milestone: All LTBs have been tested for basic functionality and are ready to be installed at Fermilab.</div>																																											
1.2.5.8	Link Receiver Board	4/1/03	11/15/04	\$12,017	\$1,160	\$0	\$13,177																																				
<div>Notes</div> <div>WBS Definition- PC-MIP board with three serial link receivers for intermodule data transfer. Design is the same as for Run 2a. 46 boards needed.</div>																																											
1.2.5.8.1	Place orders	4/1/03	4/2/03	\$0	\$240	\$0	\$240																																				
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>8</td><td>ElecTechU</td><td>100%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>12 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>12 h</td></tr><tr><td>15</td><td>MandS</td><td>240</td><td>\$240</td><td>\$0</td><td>\$0</td><td>\$240</td><td>240</td><td></td><td>0</td><td>0</td><td>240</td></tr></table> <div>Notes</div> <div>WBS definition- Get quotes, place orders, ship parts, etc</div> <div>M&amp;S Labor BOE- 12 hours @ \$20/hour for technician (shared effort with LTB place order task) based on Run 2a experience with same boards.</div>								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	8	ElecTechU	100%	\$0	\$0	\$0	\$0	12 h	0 h	0 h	0 h	12 h	15	MandS	240	\$240	\$0	\$0	\$240	240		0	0	240
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
8	ElecTechU	100%	\$0	\$0	\$0	\$0	12 h	0 h	0 h	0 h	12 h																																
15	MandS	240	\$240	\$0	\$0	\$240	240		0	0	240																																
1.2.5.8.2	Parts	4/2/03	5/29/03	\$9,297	\$0	\$0	\$9,297																																				
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>15</td><td>MandS</td><td>9,297</td><td>\$9,297</td><td>\$0</td><td>\$0</td><td>\$9,297</td><td>9,297</td><td></td><td>0</td><td>0</td><td>9,297</td></tr></table> <div>Notes</div> <div>WBS Definition- Procure parts for LRBs</div> <div>M&amp;S BOE POs from Run 2a purchases adjusted for smaller quantities (see LRB/LTB cost spreadsheet from Run 2a purchases).</div>								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	15	MandS	9,297	\$9,297	\$0	\$0	\$9,297	9,297		0	0	9,297												
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
15	MandS	9,297	\$9,297	\$0	\$0	\$9,297	9,297		0	0	9,297																																
1.2.5.8.3	Fabricate PCB	8/2/04	8/27/04	\$2,010	\$0	\$0	\$2,010																																				
<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>15</td><td>MandS</td><td>2,010</td><td>\$2,010</td><td>\$0</td><td>\$0</td><td>\$2,010</td><td>2,010</td><td></td><td>0</td><td>0</td><td>2,010</td></tr></table> <div>Notes</div> <div>WBS Definition- Fabrication of LRB PC boards by outside vendor</div> <div>M&amp;S BoE Quote from Cirexx for 330 boards + NRE (double per board cost to adjust for quantity) 46 boards * \$30 + \$180 (NRE) + \$450 (NRE) = \$2010</div>								ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	15	MandS	2,010	\$2,010	\$0	\$0	\$2,010	2,010		0	0	2,010												
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
15	MandS	2,010	\$2,010	\$0	\$0	\$2,010	2,010		0	0	2,010																																

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.5.8.4	Assemble	8/30/04	9/27/04	\$710	\$0	\$0	\$710
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	15 MandS 710 \$710 \$0 \$0 \$710 710 0 0 710						
	<i>Notes</i> WBS Definition- Assembly of LRB boards by outside vendor  M&S BoE Quote from EMA for 150 boards. They will give us the same price for a smaller quantity of boards. Amount quoted includes NRE costs. 46 boards * \$10 + \$250 (NRE) = \$710						
1.2.5.8.5	All L2 Silicon Track Trigger LRBs Delivered	9/27/04	9/27/04	\$0	\$0	\$0	\$0
	<i>Notes</i> WBS Definition- milestone: All LRBs have been received from the assembly house						
1.2.5.8.6	Test	9/28/04	11/15/04	\$0	\$920	\$0	\$920
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	8 ElecTechU 30% \$0 \$0 \$0 \$0 84 h 0 h 0 h 0 h 84 h						
	15 MandS 920 \$920 \$0 \$0 \$920 920 0 0 0 0 920						
	<i>Notes</i> WBS Definition- Test all functions of LRBs in test PC, fix problems as needed  M&S Labor BOE- 1 hour @ \$20/hour for technician per board for 46 boards based on Run2a experience with same boards.						
1.2.5.8.8	L2 Silicon Track Trigger LRB Production Complete	11/15/04	11/15/04	\$0	\$0	\$0	\$0
	<i>Notes</i> WBS Definition- milestone: All LRBs have been tested for basic functionality and are ready to be installed at Fermilab.						
1.2.5.9	BC Module	4/1/03	11/22/04	\$18,910	\$2,480	\$0	\$21,390
	<i>Notes</i> WBS Definition- Daughter board that buffers data for readout to L3 when an L2 accept is issued. Design is the same as for Run 2a. 20 boards needed.						
1.2.5.9.1	Place orders	4/1/03	4/3/03	\$0	\$480	\$0	\$480
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	8 ElecTechU 100% \$0 \$0 \$0 \$0 24 h 0 h 0 h 0 h 24 h						
	15 MandS 480 \$480 \$0 \$0 \$480 480 0 0 0 0 480						
	<i>Notes</i> WBS definition- Get quotes, place orders, ship parts, etc  M&S Labor BoE- 24 hours @ \$20/hour for technician based on Run 2a experience with same boards.						
1.2.5.9.2	Parts	4/4/03	5/30/03	\$13,000	\$0	\$0	\$13,000
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	15 MandS 13,000 \$13,000 \$0 \$0 \$13,000 13,000 0 0 0 0 13,000						
	<i>Notes</i> WBS Definition- Place order for parts.  M&S BOE- Cost of Run 2a purchases increased by approximately 10% to \$650/board for smaller quantities 20 boards * \$650 = \$13000						

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.5.9.3	Fabricate PCB	8/2/04	8/27/04	\$3,950	\$0	\$0	\$3,950
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	15 MandS 3,950 \$3,950 \$0 \$0 \$3,950 3,950 0 0 3,950						
	<i>Notes</i> WBS Definition- Fabrication of PC boards by outside vendor  M&S BoE- Cost of Run 2A purchase adjusted for smaller quantity \$950 (setup) + 20 boards * \$150 = \$3950						
1.2.5.9.4	Assemble	8/30/04	9/27/04	\$1,960	\$0	\$0	\$1,960
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	15 MandS 1,960 \$1,960 \$0 \$0 \$1,960 1,960 0 0 1,960						
	<i>Notes</i> WBS Definition- Assembly of boards by outside vendor  M&S BoE- Cost of Run 2A purchase adjusted for smaller quantity \$800 (setup) + 20 boards * \$58 = \$1960						
1.2.5.9.5	All L2 Silicon Track Trigger BCs Delivered	9/27/04	9/27/04	\$0	\$0	\$0	\$0
	<i>Notes</i> WBS Definition- milestone: All BCs have been received from the assembly house.						
1.2.5.9.6	Test	9/28/04	11/22/04	\$0	\$2,000	\$0	\$2,000
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	4 ElecEngU 6% \$0 \$0 \$0 \$0 19.2 h 0 h 0 h 0 h 19.2 h						
	8 ElecTechU 20% \$0 \$0 \$0 \$0 64 h 0 h 0 h 0 h 64 h						
	15 MandS 2,000 \$2,000 \$0 \$0 \$2,000 2,000 0 0 2,000						
	<i>Notes</i> WBS Definition- Test all functions of BCs in test crate, fix problems as needed.  M&S Labor BOE- per board for 20 boards: 1 hour @ \$40/hour for electrical engineer 3 hours @ \$20/hour for technician based on Run 2a experience with same boards.						
1.2.5.9.8	L2 Silicon Track Trigger BC Production Complete	11/22/04	11/22/04	\$0	\$0	\$0	\$0
	<i>Notes</i> WBS Definition- milestone: All BCs have been tested for basic functionality and are ready to be installed at Fermilab.						
1.2.5.10	TFC Module	4/1/03	12/8/04	\$38,397	\$4,000	\$0	\$42,397
	<i>Notes</i> WBS Definition- Daughter board that fits a trajectory to hits in SMT and CFT. Design is the same as for Run 2a. 8 boards needed.						
1.2.5.10.1	Parts	4/1/03	5/27/03	\$25,997	\$0	\$0	\$25,997
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	15 MandS 25,997 \$25,997 \$0 \$0 \$25,997 25,997 0 0 25,997						
	<i>Notes</i> WBS Definition- Place order for parts  M&S BoE-						

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																																				
"Parts" continued																																											
<u>Notes</u> See spreadsheet and web quote from Texas Instruments.																																											
1.2.5.10.2	Fabricate PCB	8/2/04	8/27/04	\$7,800	\$0	\$0	\$7,800																																				
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>15</td><td>MandS</td><td>7,800</td><td>\$7,800</td><td>\$0</td><td>\$0</td><td>\$7,800</td><td>7,800</td><td></td><td>0</td><td>0</td><td>7,800</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	15	MandS	7,800	\$7,800	\$0	\$0	\$7,800	7,800		0	0	7,800																		
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
15	MandS	7,800	\$7,800	\$0	\$0	\$7,800	7,800		0	0	7,800																																
<u>Notes</u> WBS Definition- Fabrication of PC boards by outside vendor.  M&S BoE- PCB fabrication per P.O. to Circuit Technology Inc for Run 2A TFC boards; 8 boards * \$975 = \$7800																																											
1.2.5.10.3	Assemble and rework	8/30/04	9/27/04	\$4,600	\$0	\$0	\$4,600																																				
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>15</td><td>MandS</td><td>4,600</td><td>\$4,600</td><td>\$0</td><td>\$0</td><td>\$4,600</td><td>4,600</td><td></td><td>0</td><td>0</td><td>4,600</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	15	MandS	4,600	\$4,600	\$0	\$0	\$4,600	4,600		0	0	4,600																		
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
15	MandS	4,600	\$4,600	\$0	\$0	\$4,600	4,600		0	0	4,600																																
<u>Notes</u> WBS Definition- Assembly of boards by outside vendor; usually some BGAs require rework because bad solder joints appear during original assembly.  M&S BoE- Quote from Micro Contract Manufacturing; rework \$200/board by BEST; 8 boards * (\$375 (assembly) + \$200 (rework)) = \$4600																																											
1.2.5.10.4	All L2 Silicon Track Trigger TFCs Delivered	9/27/04	9/27/04	\$0	\$0	\$0	\$0																																				
<u>Notes</u> WBS Definition- milestone: All TFCs have been received from the assembly house.																																											
1.2.5.10.5	Test	9/28/04	12/8/04	\$0	\$4,000	\$0	\$4,000																																				
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>25%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>100 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>100 h</td></tr><tr><td>15</td><td>MandS</td><td>4,000</td><td>\$4,000</td><td>\$0</td><td>\$0</td><td>\$4,000</td><td>4,000</td><td></td><td>0</td><td>0</td><td>4,000</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	25%	\$0	\$0	\$0	\$0	100 h	0 h	0 h	0 h	100 h	15	MandS	4,000	\$4,000	\$0	\$0	\$4,000	4,000		0	0	4,000						
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
4	ElecEngU	25%	\$0	\$0	\$0	\$0	100 h	0 h	0 h	0 h	100 h																																
15	MandS	4,000	\$4,000	\$0	\$0	\$4,000	4,000		0	0	4,000																																
<u>Notes</u> WBS Definition- Test all functions of boards in test crate, fix problems as needed.  M&S Labor BOE- 100 hours @ \$40/hour for electrical engineer based on experience with same boards in Run 2a.																																											
1.2.5.10.7	L2 Silicon Track Trigger TFC Production Complete	12/8/04	12/8/04	\$0	\$0	\$0	\$0																																				
<u>Notes</u> WBS Definition- milestone: All TFCs have been tested for basic functionality and are ready to be installed at Fermilab.																																											
1.2.5.11	Hotlink Repeaters	4/1/03	1/22/04	\$7,500	\$5,600	\$0	\$13,100																																				
<u>Notes</u> WBS dictionary - These boards are required to merge the outputs of two TFCs into a single hotlink output. They are boards that fit into the PC-MIP slots of the motherboard. They have a PCI target interface to receive the output of one TFC and a hotlink receiver to receive the output of another TFC, some logic in an Altera FPGA to merge the two streams, and a hotlink transmitter for output of the merged data to L2CTT. This is the only board that has to be designed for the Run 2b STT upgrade.																																											
1.2.5.11.1	Design & prototyping	4/1/03	5/27/03	\$0	\$5,000	\$0	\$5,000																																				
	<table><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr><tr><td>4</td><td>ElecEngU</td><td>100%</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>320 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>320 h</td></tr><tr><td>15</td><td>MandS</td><td>5,000</td><td>\$5,000</td><td>\$0</td><td>\$0</td><td>\$5,000</td><td>5,000</td><td></td><td>0</td><td>0</td><td>5,000</td></tr></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	4	ElecEngU	100%	\$0	\$0	\$0	\$0	320 h	0 h	0 h	0 h	320 h	15	MandS	5,000	\$5,000	\$0	\$0	\$5,000	5,000		0	0	5,000						
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																																
4	ElecEngU	100%	\$0	\$0	\$0	\$0	320 h	0 h	0 h	0 h	320 h																																
15	MandS	5,000	\$5,000	\$0	\$0	\$5,000	5,000		0	0	5,000																																

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost				
"Design & prototyping" continued											
<u>Notes</u> WBS Definition - Develop precise specifications, engineering design and layout of the board; build a prototype and test it.  M&S BoE - 4 weeks of engineering @ \$1000/week + \$1000 for prototype supplies											
1.2.5.11.2	Production	5/28/03	8/20/03	\$7,500	\$0	\$0	\$7,500				
<u>ID</u>	<u>Resource Name</u>	<u>Units</u>	<u>Cost</u>	<u>Baseline Cost</u>	<u>Act. Cost</u>	<u>Rem. Cost</u>	<u>Work</u>	<u>Ovt. Work</u>	<u>Baseline Work</u>	<u>Act. Work</u>	<u>Rem. Work</u>
15	MandS	7,500	\$7,500	\$0	\$0	\$7,500	7,500		0	0	7,500
<u>Notes</u> WBS Definition - Order parts, produce of PC boards and assemble them.  M&S BoE- Cost of hotlink transmitter board for Run 2a STT. This board has additional parts (hotlink receiver). The cost was increased by approximate cost of these parts. We need 12 boards + 3 spares @ \$500/board.											
1.2.5.11.3	Test	8/21/03	1/22/04	\$0	\$600	\$0	\$600				
<u>ID</u>	<u>Resource Name</u>	<u>Units</u>	<u>Cost</u>	<u>Baseline Cost</u>	<u>Act. Cost</u>	<u>Rem. Cost</u>	<u>Work</u>	<u>Ovt. Work</u>	<u>Baseline Work</u>	<u>Act. Work</u>	<u>Rem. Work</u>
8	ElecTechU	4%	\$0	\$0	\$0	\$0	32 h	0 h	0 h	0 h	32 h
15	MandS	600	\$600	\$0	\$0	\$600	600		0	0	600
<u>Notes</u> WBS dictionary - Test hotlink repeaters, fix problems as needed.  M&S Labor BoE - 30 hours @ \$20/hour for electronics technician based on experience with similar boards in Run 2a.											
1.2.5.11.5	L2 Silicon Track Trigger Hotlink Repeater Comple	1/22/04	1/22/04	\$0	\$0	\$0	\$0				
<u>Notes</u> WBS Definition - milestone: All hotlink repeaters tested and ready to be installed at D0.											
1.2.5.12	LVDS Cables	9/1/04	10/13/04	\$833	\$160	\$0	\$993				
<u>Notes</u> WBS Definition- Cables for LVDS serial links; need 125.											
1.2.5.12.1	Fabricate	9/1/04	9/29/04	\$833	\$0	\$0	\$833				
<u>ID</u>	<u>Resource Name</u>	<u>Units</u>	<u>Cost</u>	<u>Baseline Cost</u>	<u>Act. Cost</u>	<u>Rem. Cost</u>	<u>Work</u>	<u>Ovt. Work</u>	<u>Baseline Work</u>	<u>Act. Work</u>	<u>Rem. Work</u>
15	MandS	833	\$833	\$0	\$0	\$833	833		0	0	833
<u>Notes</u> WBS Definition- Fabrication of cables by outside vendor.  M&S BoE- Quote from Inside Track Cabling, scaled to quantity of 125 - 125 cables * \$200/30 = \$833											
1.2.5.12.2	Test	9/30/04	10/13/04	\$0	\$160	\$0	\$160				
<u>ID</u>	<u>Resource Name</u>	<u>Units</u>	<u>Cost</u>	<u>Baseline Cost</u>	<u>Act. Cost</u>	<u>Rem. Cost</u>	<u>Work</u>	<u>Ovt. Work</u>	<u>Baseline Work</u>	<u>Act. Work</u>	<u>Rem. Work</u>
8	ElecTechU	10%	\$0	\$0	\$0	\$0	8 h	0 h	0 h	0 h	8 h
15	MandS	160	\$160	\$0	\$0	\$160	160		0	0	160
<u>Notes</u> WBS Definition- Test cables.  M&S Labor BoE-											



WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost																								
"Test" continued																															
	<u>Notes</u> 8 h @ \$20/hour for Electronics Tech based on tests of similar cables for Run 2a.																														
1.2.5.12.4	L2 Silicon Track Trigger LVDS Cable Production C	10/13/04	10/13/04	\$0	\$0	\$0	\$0																								
	<u>Notes</u> WBS Definition- milestone: All LVDS cables have been received, tested and are ready to be installed at Fermilab.																														
1.2.5.13	Splitters	4/1/03	11/20/03	\$3,250	\$0	\$936	\$4,186																								
	<u>Notes</u> WBS Definition- Passive optical splitters to create data path into STT. We will need 13 units.																														
1.2.5.13.1	Go out for bids	4/1/03	6/24/03	\$0	\$0	\$0	\$0																								
	<u>Notes</u> WBS Definition- Get quotes for splitters.  Labor BoE- 8h of Fermilab Electronics Tech																														
1.2.5.13.2	Procure	6/25/03	10/16/03	\$3,250	\$0	\$0	\$3,250																								
	<table><thead><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr></thead><tbody><tr><td>15</td><td>MandS</td><td>3,250</td><td>\$3,250</td><td>\$0</td><td>\$0</td><td>\$3,250</td><td>3,250</td><td></td><td>0</td><td>0</td><td>3,250</td></tr></tbody></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	15	MandS	3,250	\$3,250	\$0	\$0	\$3,250	3,250		0	0	3,250						
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																				
15	MandS	3,250	\$3,250	\$0	\$0	\$3,250	3,250		0	0	3,250																				
	<u>Notes</u> WBS Definition- Place order for splitters  M&S BoE- Quote from Run 2a purchase. We actually paid \$250/unit rather than the quoted \$280. 13 units * \$250 = \$3250.																														
1.2.5.13.3	Test	10/17/03	11/20/03	\$0	\$0	\$936	\$936																								
	<table><thead><tr><th>ID</th><th>Resource Name</th><th>Units</th><th>Cost</th><th>Baseline Cost</th><th>Act. Cost</th><th>Rem. Cost</th><th>Work</th><th>Ovt. Work</th><th>Baseline Work</th><th>Act. Work</th><th>Rem. Work</th></tr></thead><tbody><tr><td>7</td><td>ElecTechF</td><td>12%</td><td>\$936</td><td>\$0</td><td>\$0</td><td>\$936</td><td>24 h</td><td>0 h</td><td>0 h</td><td>0 h</td><td>24 h</td></tr></tbody></table>	ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work	7	ElecTechF	12%	\$936	\$0	\$0	\$936	24 h	0 h	0 h	0 h	24 h						
ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work																				
7	ElecTechF	12%	\$936	\$0	\$0	\$936	24 h	0 h	0 h	0 h	24 h																				
	<u>Notes</u> WBS Definition- Test splitters  Labor BOE- 24 hrs of a Fermilab tech for testing.																														
1.2.5.13.5	L2 Silicon Track Trigger Splitter Procurement Com	11/20/03	11/20/03	\$0	\$0	\$0	\$0																								
	<u>Notes</u> WBS Definition- milestone: All splitters have been received, tested and are ready to be installed at Fermilab.																														
1.2.5.14	Fibers	4/1/03	11/13/03	\$1,300	\$0	\$1,248	\$2,548																								
	<u>Notes</u> WBS Definition- Optical fibers from splitters to VRBs and to STT. We will need 52 fibers.																														
1.2.5.14.1	Go out for bids	4/1/03	6/24/03	\$0	\$0	\$0	\$0																								
	<u>Notes</u> WBS Definition- Get quotes for fibers																														

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Go out for bids" continued							
	<u>Notes</u> Labor BoE- 8h of Fermilab Electronics Tech						
1.2.5.14.2	Procure	6/25/03	10/16/03	\$1,300	\$0	\$0	\$1,300
	<u>ID</u> <u>Resource Name</u> <u>Units</u> <u>Cost</u> <u>Baseline Cost</u> <u>Act. Cost</u> <u>Rem. Cost</u> <u>Work</u> <u>Ovt. Work</u> <u>Baseline Work</u> <u>Act. Work</u> <u>Rem. Work</u>						
	15   MandS   1,300   \$1,300   \$0   \$0   \$1,300   1,300   0   0   1,300						
	<u>Notes</u> WBS Definition- Place orders for fibers  M&S BOE- Quote from Run 2a purchase - 52 fibers * \$25 = \$1300						
1.2.5.14.3	Test	10/17/03	11/13/03	\$0	\$0	\$1,248	\$1,248
	<u>ID</u> <u>Resource Name</u> <u>Units</u> <u>Cost</u> <u>Baseline Cost</u> <u>Act. Cost</u> <u>Rem. Cost</u> <u>Work</u> <u>Ovt. Work</u> <u>Baseline Work</u> <u>Act. Work</u> <u>Rem. Work</u>						
	7   ElecTechF   20%   \$1,248   \$0   \$0   \$1,248   32 h   0 h   0 h   0 h   32 h						
	<u>Notes</u> WBS Definition- Test fibers  Labor BOE- 32 hrs of a Fermilab Tech						
1.2.5.14.5	L2 Silicon Track Trigger Fiber Procurement Compl	11/13/03	11/13/03	\$0	\$0	\$0	\$0
	<u>Notes</u> WBS Definition- All optical fibers have been received, tested and are ready to be installed at Fermilab.						
1.2.5.15	L2 Silicon Track Trigger Hardware Production Con	12/8/04	12/8/04	\$0	\$0	\$0	\$0
	<u>Notes</u> WBS Definition- milestone- All hardware components are ready to be installed.						
1.2.5.16	STC firmware	9/2/03	3/1/04	\$0	\$38,400	\$0	\$38,400
	<u>Notes</u> WBS Definition-  Risk Mitigation: The scope of this item is not yet that well defined, since the systems that provide inputs to the STT are all being redesigned for the upgrade. The engineering budgeted in this item will also serve as contingency in case any layouts have to be revised to accomodate changes due to obsolete parts. To mitigate this risk, I have assigned 100% contingency for this task.						
1.2.5.16.1	Update STC firmware	9/2/03	3/1/04	\$0	\$38,400	\$0	\$38,400
	<u>ID</u> <u>Resource Name</u> <u>Units</u> <u>Cost</u> <u>Baseline Cost</u> <u>Act. Cost</u> <u>Rem. Cost</u> <u>Work</u> <u>Ovt. Work</u> <u>Baseline Work</u> <u>Act. Work</u> <u>Rem. Work</u>						
	4   ElecEngU   100%   \$0   \$0   \$0   \$0   960 h   0 h   0 h   0 h   960 h						
	15   MandS   38,400   \$38,400   \$0   \$0   \$38,400   38,400   0   0   38,400						
	<u>Notes</u> WBS Definition- Rewrite firmware for STC FPGA to accomodate changes in input data.  M&S Labor BOE- Based on engineering effort to design STC firmware for Run 2a (960 hours @ \$40/hour)						
1.2.5.17	TFC Code	9/2/03	3/1/04	\$0	\$0	\$0	\$0
	<u>Notes</u> WBS Definition-						

WBS Dictionary as of 9/21/02  
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WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.5.17.1	Change TFC code	9/2/03	3/1/04	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 100% \$0 \$0 \$0 \$0 960 h 0 h 0 h 0 h 960 h						
	<i>Notes</i> WBS Definition- Rewrite software that runs in DSPs to do fits to increased number of silicon layers.  Labor BOE- Based on effort required to design Run 2a TFC code						
1.2.5.18	Downloading & Monitoring	9/2/03	2/2/04	\$0	\$0	\$0	\$0
	<i>Notes</i> WBS Definition-						
1.2.5.18.1	Update downloading & monitoring software	9/2/03	2/2/04	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 100% \$0 \$0 \$0 \$0 800 h 0 h 0 h 0 h 800 h						
	<i>Notes</i> WBS Definition- Update downloading and monitoring software.  Labor BOE- Based on effort required to design Run 2a downloading & monitoring code.						
1.2.5.19	L2 Silicon Track Trigger Production and Testing C	12/8/04	12/8/04	\$0	\$0	\$0	\$0
	<i>Notes</i> WBS Definition- milestone: STT is installed in MCH2 and all functions have been tested.						
1.2.5.21	L2 Trigger Upgrade Production and Testing Compl	2/28/05	2/28/05	\$0	\$0	\$0	\$0
	<i>Notes</i> WBS Definition- milestone: All upgrade Level 2 systems in hand and working						
1.2.6	Trigger Simulation	11/1/01	3/5/04	\$0	\$0	\$0	\$0
	<i>Notes</i> WBS Definition - This summary task descibed the simulation tasks that are needed to design and optimize the trigger while it is being developed, and afterwards to provide standard tools for simulating the behavior of the as-built system.						
1.2.6.1	L1 Cal Simulation Software	11/1/01	11/5/03	\$0	\$0	\$0	\$0
	<i>Notes</i> WBS definition - This summary task describes the development of simulation tools specifically for the Level 1 Calorimeter trigger.						
1.2.6.1.1	Develop prototype L1Cal trigger algorithm	11/1/01	1/24/03	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 50% \$0 \$0 \$0 \$0 768 h 0 h 0 h 744 h 24 h						
	13 StudentU 50% \$0 \$0 \$0 \$0 1,200 h 0 h 0 h 1,080 h 120 h						
	<i>Notes</i> WBS Definition- Use Monte Carlo simulation to design and test algorithms for jet, EM and tau clustering and global summing. Develop performance criteria for these algorithms  Labor BOE- Estimated from simulation effort expended so far.						

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.6.1.2	Optimize algorithm performance with simulations	1/27/03	11/5/03	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 20% \$0 \$0 \$0 \$0 320 h 0 h 0 h 0 h 320 h						
	<i>Notes</i> WBS Definition - Embed the stand-alone trigger simulation used for design studies of the run2b L1 calorimeter trigger into the general purpose DZero trigger simulation package ("trig_sim").  Labor BOE - 8 weeks of physicist time.						
1.2.6.1.3	Integrate algorithm into Dzero Trigger Simulation	1/27/03	7/22/03	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 20% \$0 \$0 \$0 \$0 200 h 0 h 0 h 0 h 200 h						
	<i>Notes</i> WBS Definition-						
1.2.6.2	L1 Cal/Track Match Simulation Software	1/22/03	3/5/04	\$0	\$0	\$0	\$0
	<i>Notes</i> WBS definition - This summary task describes the development of simulation tools specifically for the Level 1 Calorimeter trigger.						
1.2.6.2.1	Develop prototype L1Cal/Track match trigger algorithm	1/22/03	10/31/03	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 50% \$0 \$0 \$0 \$0 800 h 0 h 0 h 0 h 800 h						
	13 StudentU 50% \$0 \$0 \$0 \$0 300 h 0 h 0 h 0 h 300 h						
	<i>Notes</i> WBS Definition- Use Monte Carlo simulation to design and test algorithms for jet, EM and tau clustering and global summing. Develop performance criteria for these algorithms  Labor BOE- Estimated from simulation effort expended so far.						
1.2.6.2.2	Optimize algorithm performance with simulations	11/3/03	1/23/04	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 20% \$0 \$0 \$0 \$0 80 h 0 h 0 h 0 h 80 h						
	<i>Notes</i> WBS definition - Embed the stand-alone trigger simulation used for design studies of the run2b L1 calorimeter trigger into the general purpose DZero trigger simulation package ("trig_sim").  Labor BOE - 2 weeks of physicist time						
1.2.6.2.3	Integrate algorithm into Dzero Trigger Simulation	1/26/04	3/5/04	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 20% \$0 \$0 \$0 \$0 48 h 0 h 0 h 0 h 48 h						
	<i>Notes</i> WBS Definition-						
1.2.6.3	L1CTT Simulation	2/1/02	10/31/03	\$0	\$0	\$0	\$0
	<i>Notes</i> WBS Definition- Use Monte Carlo simulations and run 2a data to develop optimal equations for track finding and momentum binning.  Labor BOE- Based on Run2a L1CTTsimulation experience. Most of the simulations are performed by physicists.						

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.6.3.1	Develop prototype CTT algorithm	2/1/02	1/21/03	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 50% \$0 \$0 \$0 \$0 627.6 h 0 h 0 h 481.2 h 146.4 h						
	<u>Notes</u> WBS Definition- Use Monte Carlo simulations and run 2a data to develop optimal equations for track finding and momentum binning.  Labor BOE- Based on Run2a L1CTTsimulation experience. Most of the simulations are performed by physicists.						
1.2.6.3.2	Develop prototype CTT algorithm	2/1/02	1/21/03	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	9 PhysicistF 100% \$0 \$0 \$0 \$0 1,920 h 0 h 0 h 1,344 h 576 h						
	<u>Notes</u> WBS Definition- Use Monte Carlo simulations and run 2a data to develop optimal equations for track finding and momentum binning.  Labor BOE- Based on Run2a L1CTTsimulation experience. Most of the simulations are performed by physicists.						
1.2.6.3.3	Develop prototype CTT algorithm	2/1/02	1/21/03	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 50% \$0 \$0 \$0 \$0 960 h 0 h 0 h 672 h 288 h						
	<u>Notes</u> WBS Definition- Use Monte Carlo simulations and run 2a data to develop optimal equations for track finding and momentum binning.  Labor BOE- Based on Run2a L1CTTsimulation experience. Most of the simulations are performed by physicists.						
1.2.6.3.4	Develop prototype CTT algorithm	2/1/02	1/21/03	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 50% \$0 \$0 \$0 \$0 960 h 0 h 0 h 672 h 288 h						
	<u>Notes</u> WBS Definition- Use Monte Carlo simulations and run 2a data to develop optimal equations for track finding and momentum binning.  Labor BOE- Based on Run2a L1CTTsimulation experience. Most of the simulations are performed by physicists.						
1.2.6.3.5	Develop prototype CTT algorithm	2/1/02	1/21/03	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 50% \$0 \$0 \$0 \$0 960 h 0 h 0 h 672 h 288 h						
	<u>Notes</u> WBS Definition- Use Monte Carlo simulations and run 2a data to develop optimal equations for track finding and momentum binning.  Labor BOE- Based on Run2a L1CTTsimulation experience. Most of the simulations are performed by physicists.						
1.2.6.3.6	Optimize algorithm performance with simulations	1/22/03	10/31/03	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 50% \$0 \$0 \$0 \$0 800 h 0 h 0 h 0 h 800 h						
	<u>Notes</u> WBS Definition-						

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.2.6.3.7	Integrate algorithm into Dzero Trigger Simulation	1/22/03	7/17/03	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 50% \$0 \$0 \$0 \$0 500 h 0 h 0 h 0 h 500 h						
	<i>Notes</i> WBS Definition-						
1.2.6.4	STT Simulator	9/2/03	2/2/04	\$0	\$0	\$0	\$0
	<i>Notes</i> WBS definition - This summary task describes the work needed to modify the run2a STT simulation to work with the run2b silicon detector and run2b STT hardware.						
1.2.6.4.1	Update simulator	9/2/03	2/2/04	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 100% \$0 \$0 \$0 \$0 800 h 0 h 0 h 0 h 800 h						
	<i>Notes</i> WBS Definition- Update simulator to reflect changes in hardware.  Labor BOE- Done by physicists						
1.2.7	Administration	10/1/02	3/8/05	\$5,500	\$0	\$0	\$5,500
	<i>Notes</i> WBS Definition- The summary task associated with administration of the trigger upgrade project including management, travel, shipping, purchasing support, technical support, and software licenses including both the R&D and project phases.  M&S BOE- The cost BOEs are listed per item. The contingency is 50% for all project related items and 30% on the R&D phase which is nearing completion.  Labor BOE- The contingency for all tasks is 50%. Physicist contingency is assigned 50%						
1.2.7.1	Project Management	10/1/02	3/8/05	\$0	\$0	\$0	\$0
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	10 PhysicistU 280% \$0 \$0 \$0 \$0 13,440 h 0 h 0 h 0 h 13,440 h						
	<i>Notes</i> WBS Definition- The management carried out by the Run2b Trigger L2 and L3 project managers and their helpers. This task accounts for maintenance of the schedule, organizing meetings and reviews, maintaining and distributing documentation.  M&S BOE- no costs associated with this item  Labor BOE- There are two L2 managers of the trigger project that are physicists that are about half time on this task. There are nine Level 2 managers that spend about 20% of their time on administrative and organizational tasks for their projects. All are university physicists. The error estimate is based on the experience so far in mounting the project.						
1.2.7.2	Travel vendor and collaborator visits	10/1/02	3/8/05	\$3,500	\$0	\$0	\$3,500
	<i>ID Resource Name Units Cost Baseline Cost Act. Cost Rem. Cost Work Ovt. Work Baseline Work Act. Work Rem. Work</i>						
	15 MandS 3,500 \$3,500 \$0 \$0 \$3,500 3,500 0 0 0 0 3,500						
	<i>Notes</i> WBS Definition- Collaborator visits are needed to make contact with personnel on the projects, examine facilities and production, discuss technical choices, and meet with administrators as necessary. Major production of trigger elements will be carried out in Arizona, Boston, New York, and Saclay.  M&S BOE- Saclay: one trip for two people to Saclay at \$1500 per trip.						

WBS Dictionary as of 9/21/02  
Run IIb Trigger

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
	"Travel vendor and collaborator visits" continued						
	<u>Notes</u> Others: four trips to Boston, New York, or Arizona at \$500 per trip. Total: \$3500  Labor BOE- not applicable						
1.2.7.3	Shipping costs	10/1/02	3/8/05	\$2,000	\$0	\$0	\$2,000
	<u>ID</u> <u>Resource Name</u> <u>Units</u> <u>Cost</u> <u>Baseline Cost</u> <u>Act. Cost</u> <u>Rem. Cost</u> <u>Work</u> <u>Ovt. Work</u> <u>Baseline Work</u> <u>Act. Work</u> <u>Rem. Work</u>						
	15 MandS 2,000 \$2,000 \$0 \$0 \$2,000 2,000 0 0 2,000						
	<u>Notes</u> WBS Definition- Costs for shipping completed prototype and production boards from collaborating institutions (Arizona, Boston, Columbia, Sacaly) to Fermilab.  M&S BOE-- Shipping costs for: approximately 200 electronics cards TOTAL \$2000  Labor BOE- Not applicable						